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Engineering News-Record

Winds and Barometric Effects on the Great Lakes, *by John F. Hayford*—Shrinkage and Temperature Changes in Reinforced Concrete, *by E. H. Harder*—Building a New Concrete Bridge Over an Old One Across Miami River

From Job and Office—Hints that Cut Costs and Time for Contractors and Engineers

Building a new concrete bridge on top of an old one at Troy, Ohio

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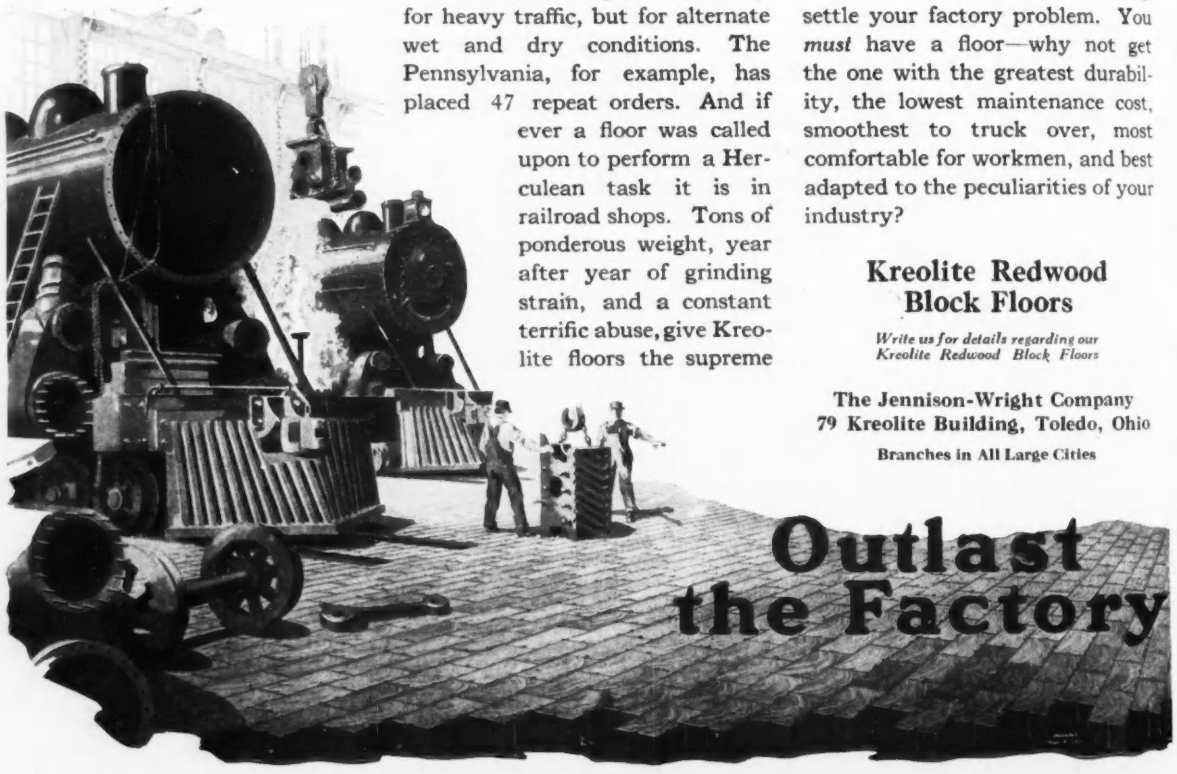

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, *Editor*
FRANK C. WIGHT, *Managing Editor*

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There Are Others

UNDERPAID engineers, of whom there are too many, should read the following advertisement in the *New York Law Journal*: "Attorney (45), American, M. A. and LL. B. from Columbia University, eight years' experience as managing clerk, just returned to city after absence of year and a half, desires position in first-class downtown office; thoroughly experienced in all matters pertaining to a general civil practice; willing and dependable and can work independently; good references; salary to begin, $18 per week." Evidently the other professions have their troubles, too.

An Opportunity to Get Together

THE hearings on the New Jersey marginal railway before the Interstate Commerce Commission and the Port of New York Authority last week mark only the beginning of a solution of the intricate terminal problem of the metropolis, a problem which the new interstate port body was formed to solve. Wisely the Authority chose to make its first issue on the most simple and elementary feature in its comprehensive plan, the co-ordination of operation over an existing marginal railway made up of a number of separately owned parts. By arrangement, only the Authority's side of the case was presented. In a few weeks the railroads will reply and then we will have, for the first time, a public expression of the railway opposition to the interstate plan. Doubtless the railways have some good arguments against the scheme, but in addition it is to be hoped that they will take this opportunity to show some agreement as to suggestions for improvement of the obviously expensive and impeding methods now in vogue for getting freight into New York from the west. The time for mere obstruction has passed. The railways must have some constructive ideas on which they can reach substantial agreement.

Municipal Foresight Needed

THE UTTER LACK of foresight of most of our cities in matters that uncontrolled are bound to cause traffic congestion and other evils is forcefully illustrated by what has happened in the theater section of New York City. Data gathered by the Physical Survey of the Plan of New York and its Environs under the direction of Nelson P. Lewis, chief of the survey and formerly chief engineer of the Board of Estimate and Apportionments of New York City, show that there are seventy-eight theaters and other commodious places of amusement resort in the area between 38th and 51st Sts. and Sixth and Eighth Aves., New York City. These seventy-eight places have a combined seating capacity of 95,294. Within a radius of only 1,000 ft. from the center of Broadway and 42nd St., forty-four of these amusement places are located, with a total seating capacity of 55,911. At opening and closing time of the theaters vast throngs make an almost intolerable congestion of foot, automobile, and subway traffic, besides putting pressure upon surface cars and elevated lines. Mr. Lewis points out the London practice of withholding building permits for places of public assembly until after the police and fire departments have reported as to the effect of these places upon both traffic congestion and the fire hazard. In New York apparently there is nothing of the sort. Although the New York theater congestion is unparalleled in degree other American cities show the same general neglect of various factors that may lead to traffic congestion. The matter demands immediate attention from the municipal authorities of all our cities. Municipal engineering departments should take the lead even though in some cases they may appear to be stepping outside of any function ascribed to them in municipal charters.

Studying the Great Lakes

ANOTHER large-scale research in the field of civil engineering is placed before the world, in the study of the Great Lakes hydrography reported in this issue. It expresses the same high scientific spirit as is found in the famous track stress investigation, and takes a place with it in the small list of engineering classics. Dealing with a problem of extreme intricacy, it proceeded toward its objective by a most toilsome route, and finally succeeded in reaching definite results which contain a satisfactory solution of the problems taken up. The Great Lakes justify an intensive study of this kind, in view of their remarkable character and their intimate relation to the interests of the country at large. Heretofore we have known but little of their quantitative characteristics. Their relation to the national economy depends upon the water supplied to the basin, upon the water losses and upon fluctuations of level. The latter, which formed the specific subject of the present study, represent merely the starting point of an attack upon all the problems indicated. The ultimate result of the investigation will be a full quantitative determination of the hydrographic features of the Lakes. Even apart from the results of the study, its methods make it valuable to the civil engineering art. The analysis of intricate phenomena by rational formulation followed by least-square verification is a most powerful process. It has been too little used in application to lengthy records of varied natural phenomena. The example of its application and of its effectiveness given by Mr. Hayford's work will inspire others to fuller use of the method. Whether the old but ever new question of the Chicago water diversion, which is mentioned at the close of our abstract, is directly related to fluctuations of level in the Lakes, appears quite doubtful. For its best appreciation the present study should be considered as being free from any connection with Drainage Canal matters. In the ultimate development of the study when it leads to a determination of total net flow, its application to the Chicago problem will be more direct.

Truck Haulage Values

AN ANALYSIS of truck haulage in which light, medium weight and heavy trucks are compared, is presented in this issue by A. E. Horst, highway contractor. The data relate to haulage for road construction and are based on records of actual performance and costs. It is not the specific figures given, however, that make this analysis of most interest and value. These qualities lie instead in the fact that a way is indicated by which highway contractors can appraise the relative desirability of small or large trucks for any set of conditions. Other conditions of wages and prices and rates of depreciation than those assumed may easily exist, but they can be substituted and the comparison conducted in exactly the manner adopted with the assumed figures. The contractor will then have a knowledge of truck values that few contractors have when they are buying trucks. As things are now contractors are dependent on the truck salesman to get information of the kind noted in this article. It is therefore, as a guide to a way of knowing more of truck haulage economics in road construction, that the article and tabulations published are of general utility.

Outguessing the Future

CONFERENCES, to settle national or international troubles, have come to have a pretty bad name. Too frequently in the past few years have they come to nothing. The recent business cycle and unemployment conference report has, therefore, the handicap of its class to overcome. In spite of this the report is thought provoking, and its effect will be heightened when the full text of its more extended related study is made available. The essence of the suggestions made now are plain enough. Business moves in certain readily recorded cycles; the problem is so to judge the future by the past as not only to foresee the coming trend—which has been the common habit of the successful business man—but to control that trend for the benefit of the world. It is proverbial that the way to grow rich is to buy low and to sell high. Some men have this knowledge instinctively. Others, doubtless, have built up theories of how to do it, which satisfy themselves. The committee would make such knowledge general. We must not delude ourselves that this will be easy. There is no simple touchstone by which we can outguess the future, but there do seem to be certain fundamentals of economics which, if properly studied and properly recorded, will make it possible to flash warnings, which being observed will tend to keep progress on an even keel. In its advocacy of more statistics and more research, the committee is on solid ground; in its recommendations as to banking it is in a realm on which many theories are held but which only practice can prove. It is in its suggestion that some workable scheme of unemployment insurance be perfected, that the committee has hit on a basic need. If means can be devised whereby the working man is either guaranteed full time or at least carried over his jobless weeks, we will be approaching the millennium, for, after all, it is the man who has no leeway between income and legitimate expense who suffers most in depression and whose sufferings react to discommode the entire body of the people. The employment conference's report does not promise any early approach of the millennium, but it is valuable as a step in a proper study of how it is to be achieved.

The Civil Engineers and Society Co-operation

IN A decisive vote the American Society of Civil Engineers has once again refused to join the Federated American Engineering Societies. The performance of the federation in the two and one-half years since the last vote has not served to bring any civil engineering sentiment to its side; indeed, the trend is slightly the other way, for 581 more votes were cast against joining than in 1920. Further than that the trend has been national and not sectional. In 1920 nine of the thirteen districts voted against the federation, in 1923 twelve of the fifteen are in opposition. Nor is the common claim that New York dominates the opposition valid, for had all the metropolitan votes been favorable to the federation it would still have lost by over 150 votes. Leaving out New York altogether the adverse majority was over 1,000. The vote, therefore, is final. As at present constituted the federation does not appeal to the civil engineers.

There should be no misunderstanding as to just what this vote means. It was not on the question of co-operation between engineers; the issue was plainly on the record of the F. A. E. S. as the agent for such co-operation, with the future potentialities that record promised. The opposing arguments of the civil engineers' committees may be taken as representing the situation as it appealed to the members. The advocates believed that the federation, approximately as constituted, is the best means for bringing to bear the combined influence of the engineering profession on public affairs and public opinion. The opposition believed that the federation is unresponsive and unrepresentative and that it has reduced rather than enhanced the influence of engineers. It felt, too, that the society can better serve the profession through devotion to its own technical activities and both the profession and the public through some less expensive and more independent kind of co-operation.

In spite of the voluminous and widely circulated defenses of the F. A. E. S. we believe its record warranted the civil engineers' vote. In its three years the federation has actually done very little and what has been done has been the work of a few men and not of the members of the societies that make it up. The same may be said of many societies, but the avowed purpose of the federation is to speak for the engineers of America so that its concentration of effort and opinion has a special significance. The waste report and the twelve-hour day study are admirable efforts, but they are no more the work of the engineering profession—or even of the F. A. E. S.—than any report or study by a group of engineers. The recommendations of the various committees may be judicious but they remain the views of certain selected men and not the views of a body of engineers. In other words, a representative council, with a highly variable representation unit, cannot in its occasional meetings voice the will or thought of the thousands it imperfectly represents.

Freely admitting that the federation is an honest attempt to fill a need long expressed by the best engineering thought, the need of some co-ordinated efforts by engineers of all kinds and from all places to impress what seems to be the group opinion of the profession on the general thought of the nation—freely admitting this, the federation has not succeeded in its aims. Among other things, it has mismanaged its publicity in the mistaken idea that engineering will gain prestige

by the over-emphasis of a few individual engineers; it has, whether it wanted to or not, set up in Washington a lobby, which where possible has urged governmental action or made decisions authorized by the council (though rarely if ever by the members themselves) but which on occasion has been forced to take quick action along lines thought best by the Washington office but always in the name of the 50,000 or more engineers who could not possibly have anything to do with such a decision. Its leading spirits have shown the most naïve inability to understand that the thoughts and actions of a few men, however broad minded and public spirited, cannot be circulated as the views of a great profession.

These things, we believe, were in the minds of the members of the American Society of Civil Engineers who voted against the federation. They were voting against a record and not against an idea. The danger now is that the vote be taken as putting a quietus on any co-operation between the civil engineers and those engineers now making up the federation. Such a conclusion would be deplorable. So final an authority on the federation as Herbert Hoover has said that "the engineers of America can never express themselves as fully or with as much force and influence in matters of public interest as they could if they embraced the civil engineers." The civil engineers themselves have voted that they are strongly in favor of some kind of co-operation. In spite of the latest vote we believe that that sentiment still prevails, and it should be capitalized.

For two years those behind the federation have gone ahead on the idea that it was a perfected organization. Take it or leave it, they said in effect to the civils, all the time bringing to bear all possible pressure to make them take it. If that attitude persists and they take the stand that they are well rid of the civil engineers, the influence of the federation will steadily decline. If they cannot see why the only group of engineers who have been permitted to express themselves (no other of the major societies has had a referendum) cannot accept the federation, they are too short-sighted to represent truly the engineering profession. If, on the other hand, they take to heart this vote and make some effort to reform or even to make anew the federation idea to meet the objections which controlled the adverse vote, progress will surely, though doubtless slowly, be made toward the very necessary integration of all branches of the engineering profession.

A similar obligation rests just as strongly on the members of the American Society of Civil Engineers. Thirty-six percent of those voting want the federation as it is; enough more to make a large majority unquestionably favor some sort of co-operation. The thought of this majority is not co-ordinated or expressed but there can be little doubt that it believes that engineers need more recognition from the world and that the world needs the kind of thinking that engineers can give to its problems. The federation as an attempt to supply these needs is not acceptable to the civil engineers, but the society is none the less under obligations to consider, actively and not merely receptively, means whereby the desired ends may be reached. They cannot, nor do any but a few of their members want them to, set up a policy of isolation or self-sufficiency. They need the other engineers and the other engineers need them to present to the world a united engineering profession on those matters on which a united profession has a right to an opinion.

No one has authority to lay down a basis of discussion as to co-operation between the American Society of Civil Engineers and other engineers, but it would be fair to start on the assumption that the civil engineers would be interested in a looser form of co-operative organization, one that is more representative and more responsive and which is neither so expensive or so centralized as the F. A. E. S. has proved itself to be. Both sides would be serving the profession each is anxious to benefit by forgetting the bitterness of the late campaign and starting anew on some such basis to build up a real co-operative movement among engineers.

Seeking for Steel Economy

ONE important phase of the last few years' movement toward greater economy of construction has been a seeking for more efficient utilization of structural steel through higher working stresses. Doubtless the pressure of high prices and the competition of other materials, chiefly reinforced concrete, was a motive, but essentially the steel stress reform movement is part of a larger movement to make productive our developed engineering skill by eliminating excess safety margins. The conventional standard of 16,000 lb. per square inch for structural steel in tension and bending is the point of attack. Several voices have already been raised in favor of increasing this standard to 18,000. Now a weighty pronouncement is added to them by the report of an engineers' committee of the steel fabricators, summarized in this issue. The committee concurs in the 18,000 recommendation, but stipulates certain specification requirements that mean additional changes in designing and construction practice.

Meanwhile, bridge engineers have gone beyond their brethren of the building field by designing with working stresses of 20,000 lb. as instanced by the case of the Michigan Central arch, described in our pages some weeks ago. If such a stress is safe, and if bridge service is more severe than building service, the latter should be able to use still higher working stresses; but building engineers have not yet been willing to apply this conclusion practically. The fact is that they have not the same certainty with regard to their work that bridge engineers derive from stress measurements—scanty as these latter are. In consequence they are compelled to resort to one of two courses: either to fix a safety margin by estimating separately the allowances which it must cover, or else to make a cautious step forward in working stress on the basis of the fact that no steel building has failed except because of intolerably bad designing or construction. Which course was pursued by the committee is not revealed in the report, but it may be said that structural engineering would benefit from a clear statement on this point. Regardless of the reasoning back of the report, however, the structural engineer has to keep two facts in mind. First, purchasers of building steel accept and use a material of lower grade and greater variation than that which bridge engineers demand and get. Second, there is a certain small amount of bad or slipshod construction in the structural field, which requires to be safeguarded by an extra safety margin, handicapping the conscientious designer. Of these two obstacles to structural progress the latter is much the worst. The structural profession owes it to itself to place its work on a stress basis free from allowance for bad work, and then to fight hard for the elimination of bad work.

Building a New Concrete Bridge Over an Old One

Piers for Adams St. Structure Over Miami River at Troy Strengthened for Heavier Loads—Three New Arches Added—Old Arch Rings Support Formwork for New

THE unusual feature of constructing a new concrete bridge on top of a similar structure already in place, using the old bridge as support for forms for the new, was present in the reconstruction of the Adams Street bridge at Troy, Ohio. The reconstruction, part of the work being done by the Miami Conservancy District, was carried out under the direction of A. F. Griffin as division engineer, and W. D. Rogers as superintendent. The scheme of using the old bridge as a support for the new construction and of removing it afterwards was worked out by J. H. Kimball, assistant chief engineer of the district. The detail designs were made by H. G. Peterson. Price Bros. Co. were the contractors on the underpinning and reinforcing of old piers.

Official Plan Proposal—The official plan of the District originally proposed an improved channel for the Miami River at Troy following the old river closely and using the bridges as they then stood. Floods were to have been taken care of by making the levee on the north side of the river of limited height so that a large flood flow would overtop the banks and make use of the low ground on the north. The plan required, however, that the Adams Street bridge should be enlarged whenever conditions should be such as to make complete protection of the land on the north side of the river desirable. The demand for this protection appeared before much work had been done at Troy, and this fact together with the growing feeling that the bridge should be rebuilt led to a change in the official plan. The old bridge was built in 1913 and consisted of four reinforced-concrete arches. The foundations were very shallow, the big flood scouring the bed of the channel near the bridge to a depth of several feet below the pier footings. The tops of the arches were also so low as to be submerged in extreme flood and the waterway was far from adequate. It also developed that the concrete of the structure was of rather poor quality. The Conservancy Law requires the owners of bridges of inadequate waterway to make such modifications as the District requires at their own expense. The Adams Street bridge was a structure built and owned by the County of Miami, but the County Commissioners requested the District to make the necessary reconstruction at the County's expense.

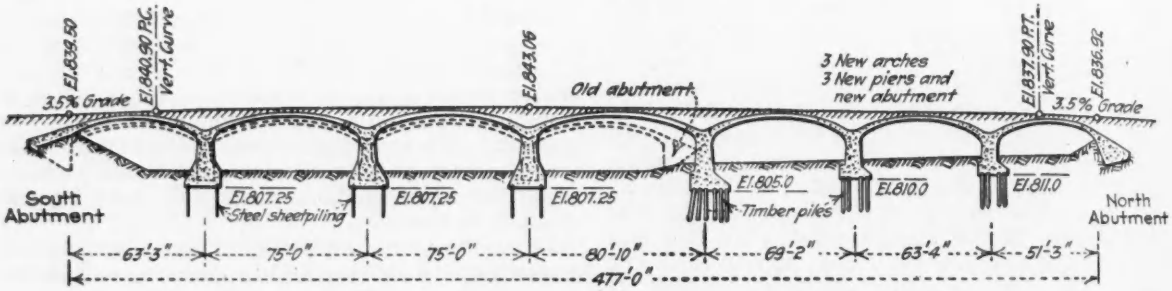


FIG. 1—SECTION OF RECONSTRUCTED ADAMS ST. BRIDGE OVER MIAMI RIVER AT TROY, OHIO
Dotted lines show the original position and size of piers, abutments and arches.

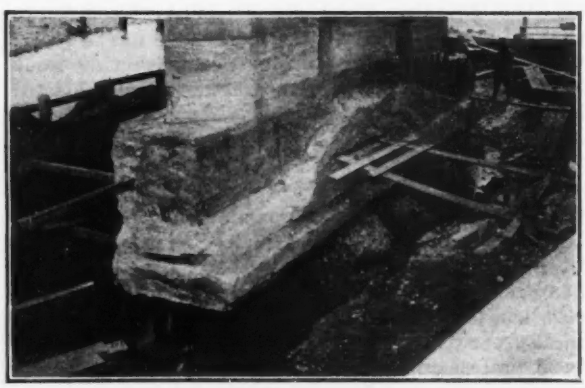


FIG. 2—STRENGTHENING OLD PIER FOOTINGS

The reconstruction of the bridge, as described in a recent issue of the Miami Conservancy *Bulletin*, presented an interesting problem.

Reconstruction Procedure—Ordinarily, wrecking an old structure of this sort would be considered first. The District, because of the size of the possible wrecking job and its expense, decided it would be cheaper to underpin and reinforce the old piers and use them to carry the new bridge and to use the old arches to carry the falsework for the new and to add extra arches at one end, rather than to build an entirely new bridge.

Some definite advantages in using the old structure as a basis for the new were recognized. Danger from floods washing out timber falsework was eliminated and less timber and labor expense would be required for formwork. Then, no additional right-of-way was required to be purchased. Considerable saving in the volume of concrete was effected. The principal difficulties were found in underpinning and reinforcing the old piers and in venturing upon a plan without any precedents upon which to base procedure methods.

Enlargement of Footings—The first job in reconstructing the old bridge was the enlargement and deepening of footings. The rebuilt footings are almost twice as wide as the old ones and extend about 3 ft. deeper into the river bed. Cofferdams of earth were thrown up around the piers, the water was pumped out, and the material around the footings excavated by hand.

Taking one-fourth of the length of the old footing at a time, excavation was carried 3 to 4 ft. below the bottom of the old footings and then underneath. During the baring of the pier foundations the discovery was made that some of the foundation piles extended only 3 or 4 ft. below the concrete. Steel sheetpiling 15 ft. long was driven 1 ft. inside of the line of the new footing, projecting up 1 ft. into the footing. Concrete was packed into the space underneath the old footing and around the old piles, out past the line of the sheetpiling. When the concrete was set the next section was dug out and the operation repeated. No measurable settlement was noted at the end of this work.

When the underpinning was completed holes were drilled through the old piers and tie rods placed through them. Then a jacket of concrete was placed entirely around the old piers, the network of steel in the jacket being held in place by the tie rods.

Spandrel walls, sidewalks, fill and paving, being a considerable part of the dead-load on the old bridge, were removed before much work was done in order that as little load as possible would be on the piers while they were being enlarged. It was necessary to remove these carefully and to unload all arches simultaneously and uniformly; otherwise, unbalanced forces might have pushed over one of the piers. Most of the work was done by hand. Small shots of dynamite were used in breaking up concrete wherever possible in order to lighten the handwork.

The reconstruction work on the piers and the south abutment did not turn out to be as difficult as was anticipated. Difficulty of driving sheetpiling in the restricted space under the bridge was overcome by the use of a small compact steam hammer. Since the north abutment had to be replaced by a new pier immediately north of it, reconstruction there was complicated. As the excavation for the new pier removed the earth support from behind the old abutment, some means of supplying a temporary support until the old bridge was taken down was necessary. This part of the work is indicated by Fig. 5. Heavy timbers wedged against concrete footings were placed in line with the direction of the force against the abutment and braced to prevent buckling. The pressure from this support was developed by the use of jacks and heavy timber wedges. Then the excavating was done and when the pier was poured the concrete was boxed around the timber. The holes so left were filled in after the completion of the bridge and permitted the removal of the braces for the old abutment.

FIG. 3—FORMS FOR NEW ARCH RINGS IN PLACE

Placing New Arches—When the piers had been reconstructed and all the upper part of the old bridge, except the arches, was removed, the forms for the new arches were built on top of the old bridge. The only difference from the forms ordinarily used on such work was in the posts, for instead of long bents resting on piles or sills in the river bed the posts were short and rested on top of the old concrete arches, leaving the waterway unobstructed. As the posts carrying the arch forms for the new spans on the north end rested on the ground, these arches could be poured in the usual way. However, on the part of the new bridge that rested on the old a different method was necessary. It was calculated that pouring each new arch complete would have caused an unbalanced loading on the piers that might have been dangerous. So each new arch was poured in three longitudinal sections, one section being poured on all of the arches and then another and finally the third. By

proceeding in this manner the unbalanced thrust on the piers did not exceed a safe figure. A difficult part of the reconstruction was the removal of the old arches after the new arch rings had set. This was done in the following manner:

Underneath the bridge a trench was dug deep enough so that the old concrete falling into it would all be below the grade of the improved channel. Then 1-in. holes were drilled through the old arches 7 ft. apart longitudinally and 3 ft. apart laterally, and corresponding holes were cast into the new arches above. Due to the same difficulty about having too large an unbalanced thrust on the piers, the old arches had either to come down all at once or else be removed uniformly. The practical difficulty of so managing affairs that all of the arches would let go and fall at the same time was so great that this method was not seriously considered.

Demolition of Old Arches—The piecemeal method of demolition was therefore decided upon. The holes mentioned were so arranged that bolts could be run through them, taking up a bit in the lower arches, suspended from the upper ones in case that, during operations, the old arches showed any signs of failure. Scaffolding was then suspended from the upper arches by means of rods run through the holes mentioned, through the new arch rings, and workmen with jap drills and sledges and small charges of dynamite began taking out little bites from all of the arches working in about the same rate on each.

The network of reinforcing steel held the old concrete together very well and the steady nibbling reduced each arch to a very narrow rib without any necessity arising of suspending any of the old structure from the new arch ring.

As soon as the wrecking operations were completed, the new spandrel walls and sidewalks were poured. Sidewalks are cantilevered out without brackets.

Redesign Considerations—Considerable study was required in the design of the new bridge because of the limiting conditions of street approaches and the necessity of conforming to the span lengths of the old bridge arches. The length of the spans of the old bridge governed the length of the three comparatively short

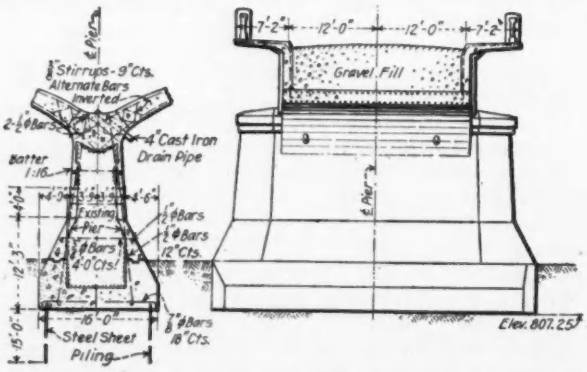


FIG. 4—ELEVATION AND SECTION OF REINFORCED PIER

spans that were added at the north end as the principle was approximated of having the center span the longest and having the spans decrease somewhat uniformly toward either end. The deep water channel through Troy follows the old river channel and runs under the

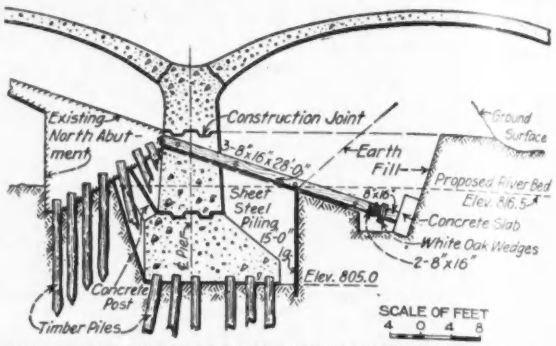


FIG. 5—OLD ABUTMENT TEMPORARILY STRENGTHENED TO TAKE ARCH THRUST DURING RECONSTRUCTION

old bridge. The entire bridge is designed to carry a concentrated live-load of one 20-ton truck with 14 tons on the rear wheels and 6 tons on the front wheels. The sidewalks are designed to carry a live-load of 100 lb. per square foot. The materials will receive a maximum stress under total dead and live-loads of 500 lb. per square inch for the concrete and 14,000 for the steel. These stresses are considered about one-fourth of those which would break the materials. A variation of 80 deg. in temperature was considered a maximum.

In designing the forms, care was taken to reduce the number of vertical joints to the minimum. The posts supporting the form work for the three northerly spans rested on sills embedded in concrete. Pins set to record the settlement of the arches showed a maximum settlement of one-fourth inch in the four arches built over the old bridge, and a maximum of five-eighths inch in the three northerly arches, readings on these being taken before the concrete was placed and after the forms were removed.

The article in the *Bulletin* from which the material herein was taken was written by C. N. Phillips, office engineer. Charles H. Paul is chief engineer of the district.

Grade Crossing Protection in Illinois

New rules for the construction and protection of highway grade crossings, issued by the Illinois Commerce Commission, provide that railways must reconstruct crossings so as to make the plank or other paving level with the tops of the rails over the entire distance between points 16 in. beyond the outside rails. The width of paving is to be not less than 18 ft., or 30 ft. for hard roads. If the graded or traveled width exceeds 18 ft. the paving must be for the full width. Road approaches to new crossings must be built by the railway with grades not exceeding 1 per cent for the first 25 ft. from outside rails and thence not exceeding 3 per cent within the right-of-way lines, the width of approach to be that of the traveled or graded part of the highway and not less than 18 ft. Clearing of brush and trees at crossings is to be done by the railway for 500 ft. on each side of the crossing and by the highway commissioners for 300 ft. along the road. Where gates are installed, they must be maintained and operated for each 24-hour period, except that when it is certain there will be no traffic for at least six hours the gates may be left without an attendant for such period. Warning signs are to be set by the railway on both sides of crossings outside of incorporated cities and villages, with stop signs at crossings designated as extra-hazardous.

Cable Net Used to Clear Boulders From Harbor Entrance

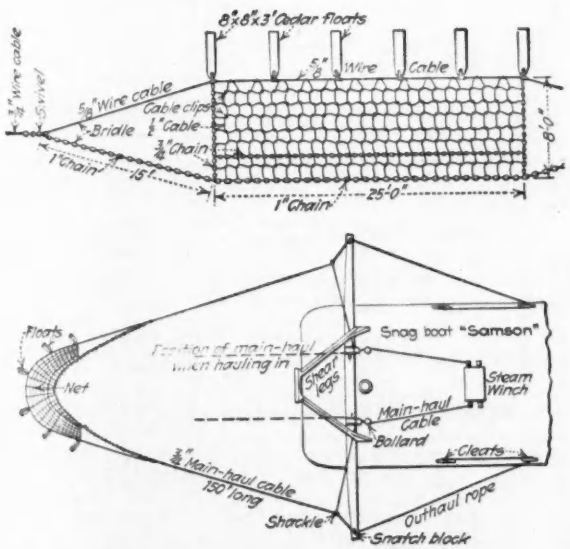
Boulders Up to 6 Ft. in Diameter Removed From Ship Channel at Vancouver, B. C., at Cost Much Less Than Plan Requiring Diver

By C. C. Worsfold

District Engineer, Department of Public Works, Canada
New Westminster, B. C.

THE entrance to Vancouver Harbor, B. C., has been dredged to a depth of 35 ft. at low tide, and widened to 900 ft. on the 35-ft. contour at the narrowest point. On sweeping the channel after the dredging was completed to ascertain if any high spots remained, numerous loose boulders were found of sizes ranging up to 5 or 6 ft. in diameter. After removing some of these with the aid of a diver, a very much quicker and less expensive means was devised for using a net made of wire cable and operated from one of the snag boats of the Dominion Government dredging fleet.

Difficulties of the work as at first undertaken were that the heavy current in the narrows, which is sometimes as much as seven knots per hour, made operations with a diver slow and expensive. It was possible for a diver to work only at slack water periods or when there was but little variation in the tides. The most favorable tides occurred only two or three days each month and there was not more than one hour at each of these tides during which he could work under water. In ordinary tides the duration of slack water is only a few minutes. Under these conditions the removal of two or three boulders per day was the best that could be done even under favorable circumstances.

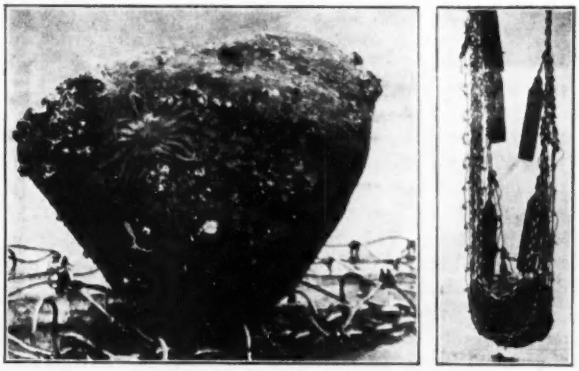


DETAILS OF NET AND PLAN OF DRAGGING RIG

After a total of sixteen working days with a diver, in the course of which nineteen boulders were removed, it was figured that the cost for dredging, crew, equipment, diver and all incidentals totaled $2,000, or $105 per boulder. Endeavor was then made to find a better method of carrying on the work and the idea of a drag net was developed.

The drag net, made of ½-in. galvanized wire cable, and shown in the accompanying illustrations, is 25 ft. long by 8 ft. wide, the cable being clipped together to give a 1-ft. mesh. The chain at the bottom gives weight to the lower edge and like the chains at the ends affords a convenient means of edging off the net as the cable is woven into the chain links. A ⅝-in. cable was used for the top to keep the top as light as possible.

The top cable and the bottom chain are continued beyond the ends of the net to form a bridle ending in a swivel 15 ft. from the net proper. From this swivel



BOULDER LANDED BY MEANS OF SHEAR LEG TACKLE

Boulders up to 16 tons in weight with dimensions ranging up to 6x6x8 ft. have been taken aboard this way. The size of the one shown above is 4x4x3 ft.

When a "catch" is made, out-haul lines are cast off and as the bridle comes to the surface the net becomes a sling; the shear legs then take the load and swing it in on deck.

there is 150 ft. of ¾-in. cable running to the winch on the snag boat with which the net is dragged along the bottom.

Six floats made of dry cedar, 8 x 8-in. in section and 3 ft. long, give a buoyancy of 300 lb. in all and are fastened at equal distances along the cable at the top of the net. This is the amount of flotation calculated to hold the upper 6 ft. of the net in a more or less vertical position while still allowing the 2-ft. section between the chains at the lower edge to lie flat on the bottom so that when a boulder is encountered the whole of the net will not drag under it, the top being brought forward by the ¾-in. wire rope which has the same length as the bottom 1-in. cable. Between the top cable held up by the floats and the chains at the lower edge a bag or sling is formed which serves to catch and retain the boulders.

The dragging is done by propelling the snag boat either up channel or down, with a fixed length of main-haul cable paid out and held well out toward the end of the outriggers by tension in the outhaul cables.

Men stationed on the outriggers can tell by the tension on the lines when a boulder has been caught. With a boulder in the net the boat is stopped and the outhaul lines are let go. The two main-haul lines from the net are then thrown over the bow and the net is hauled up by the winch until the swivels are on deck. The main tackles in the shear legs can then be hooked into the swivel ring and the net raised from the bottom and swung in on the deck. After several boulders have been taken aboard, the boat is run to the dumping ground and the boulders put overboard.

The largest boulder brought up weighed 16 tons and its diameters was approximately 6 x 8 x 6 ft. The sizes

ranged from this all the way down to the smallest that the mesh of the net would retain. The greatest number brought up at one lift was ten, which varied in size from 1 ft. up to 3 ft. in diameter. As many as thirty boulders have been brought up in one day and of course there were many drags in which no boulders were caught.

In preparation for the work of boulder removal, the channel bottom was surveyed and the location of the boulders charted. The best practical means of marking the location in the channel, as a guide for the work of the snag boat, was by means of range flags on shore. As no range flags up and down the channel could be placed, it was, at best, difficult to drag any exact spot that could be indicated only by cross channel ranges, particularly when the current was swift.

However, 526 boulders were removed with the net in about 25 working days. The total cost of the operation was $221 for materials for the net and $100 time for the crew of the snag boat while making up the net, plus the $100 per day snag boat charge for the 25 working days. This totaled $2 821 in all, or $5.20 per boulder, which is about one-twentieth the cost per boulder by the method that required the diver.

The net was devised by the writer, who acknowledges as factors in its successful construction and operation the co-operation of Captain R. C. Menten of the snag boat "Samson" and K. W. Morton, the writer's assistant engineer who worked out the details of design.

Economic Study of Trucks for Road Construction

Light and Heavy Trucks Compared on Ton-Mile Basis-Costs and Plant Investment—Eight Speed Rates Considered

Condensed from a paper read at the annual convention, Jan. 16-19, 1923, *of the American Road Builders Association by A. E. Horst, Henry W. Horst Co., Rock Island, Ill.*

IN determining the economical truck equipment to employ in hauling road materials the following conditions have to be regarded:

General Conditions:

1. Distance materials are to be hauled.
2. Will the road support the wear and tear of heavy traffic?
3. Time lapse before getting onto subgrade after a rain.
4. Investment allowed in estimate for hauling equipment.

Investment:

1. Comparative original costs.
2. Comparative depreciation.
3. Comparative investment in proportion to load-per-day carried.

Operation and Maintenance:

1. (a) Ease of securing drivers. (b) Rate of pay.
2. (a) Ease of securing experienced mechanics. (b) Rate of pay.
3. (a) Ease of securing mechanical parts and comparative costs. (b) Will stocking of parts be necessary? (c) Likelihood of delay in waiting for parts.
4. Cost of tires.
5. Life of tires.
6. Comparative consumption of gasoline and oil.
7. Comparative cost of maintenance of road for various type of trucks.

To what extent does each affect the cost of transportation. In order to avoid generalities and arrive at some definite conclusions, let us assume the following:

TABLE—COMPARATIVE TRUCK COSTS AND PERFORMANCE BASED ON WEIGHTS AND SPEEDS

| | | |

1. Grades not to exceed 4 per cent and road conditions similar to those found in the states of Indiana, Illinois, Iowa and Michigan.
2. Material hauled in proportioned batches to the mixer and not dumped on the sub-grade.
3. The use of a turntable to turn trucks at the mixer.
4. Gasoline at 25c. a gallon.
5. Lubricating oil at 60c. a gallon.
6. A 10-hour working day.
7. 150 working days per year.
8. 800 sq.yd. of pavement 7½ in. thick laid per day.

With these assumptions in the background, let us classify trucks of 2-ton capacity and less as light trucks. Let us depreciate them over 2 years of 150 workings days each, thus making the average yearly expenditure on a truck one-half of its original cost (one-half of $1,000) plus yearly expense of say $200 or a total of $700. This class of trucks is designated as Type 1.

Similarly, for sake of comparison, let us classify trucks of 2-ton to 3½-ton capacity as medium trucks, depreciated over 3 years with average yearly expenditure of $1,793. These will be designated as Type 2, while all trucks of over 3½-ton capacity will be classified as heavy trucks, depreciated over 4 years with average yearly expenditure of $1,844. These trucks will be designated as Type 3.

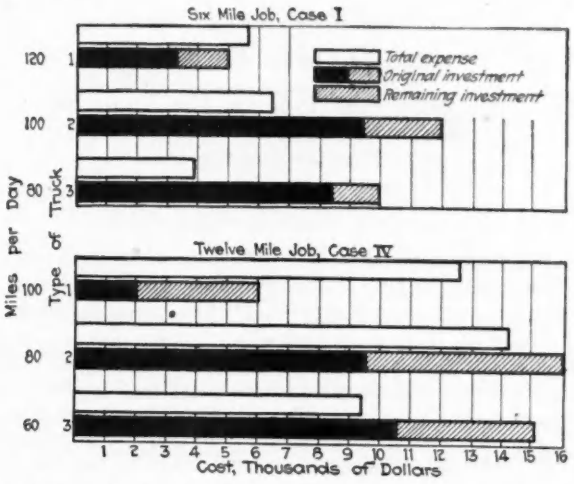


FIG. 2—INVESTMENT COSTS IN THREE SIZES OF TRUCKS

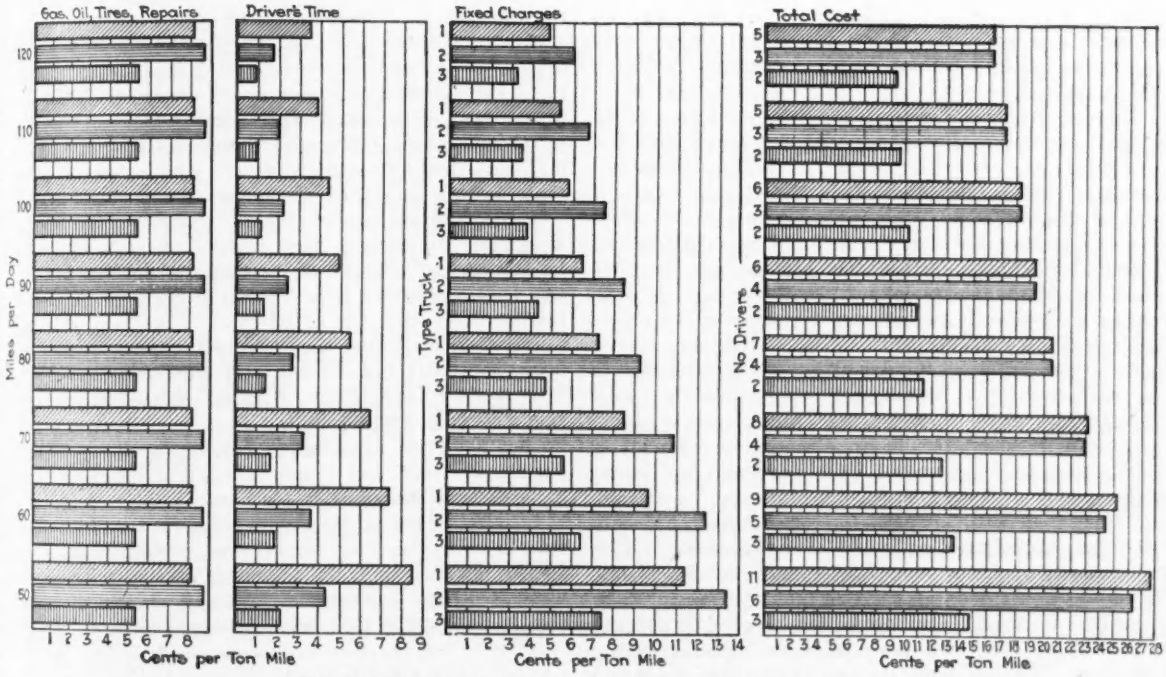


FIG. 1—TON-MILE COSTS FOR THREE SIZES OF TRUCKS

The table gives a cost, performance and investment comparison of the three types of trucks at speeds from 50 to 120 miles per day. Fig. 1 shows graphically the ton-mile costs given in the table for each truck for each speed. Using the same figures, Fig. 2 shows the comparative total operating cost, original investment and remaining investment on the three types of truck, first, on the completion of a 6-mile job operating 120, 100 and 60 miles a day and, second, on the completion of a 12-mile job operating 100, 80 and 60 miles a day.

In view of these tabulations and charts and the apparent economy of Type 3 consider the following:

1. Can we afford to have but 3 trucks for handling 12 miles of work? Suppose one truck breaks down, we operate but 66⅔ per cent efficient whereas with one of six light trucks out of commission we operate 84 per cent efficient.

2. Can we afford to take chances with heavy loads on highways which are being paved because they cannot take care of the present ordinary traffic?

3. Can we afford to put one additional man every one-half mile on our sub-grade over and above those required to keep the grade in shape for light trucks? (This additional expense alone amounts to over $1,600 on a 12-mile job).

4. Compare a jerky operation with 3 trucks of 4 batches each with the more continuous operation of 6 light one-batch units.

5. Compare the investment of $15,000 in a fleet of 3 large trucks for 12 miles of work after which we still have $10,600 tied up in 3 units, with an investment of $6,000 in 6 lighter trucks and, after 12 miles of work, but $2,000 tied up in 6 units.

Each type of truck has its place in the transportation problems of the highway contractor. It is only possible, however, to secure the best and most economical equipment for each job through an intelligent analysis of all factors involved in the operation of the truck. In other words, let us make an accurate analysis of the ton-mile cost.

Terrazzo Floor for Industrial Shoe Factory Building

Tests Determine Best Type for Use Under Severe Traffic Conditions—Satisfactory After Nineteen Months

By H. S. Wright

Portland Cement Association, Boston, Mass.

Terrazzo floors have long been used in corridors and other public spaces of public and semi-public buildings, but the advantages of this material for floors of industrial plants are not so well appreciated. Approximately 210,000 sq.ft. of terrazzo floor was laid at the shoe manufacturing plant of Hilliard & Merrill, Inc., of Lynn, Mass. Recent inspection after 19 months of severe trucking showed the floors to be in better shape than when first laid. Mr. Nichols, the plant engineer, outlined the method of construction which was carried out by the William M. Bailey Co., Boston.

The rough slab was first picked, swept clean and washed with clean water. After a thorough cleaning, the floor was again wet down and a 1:1 cement-sand grout was brushed into all holes in the floor, bringing the rough slab approximately to an even grade. One-inch round steel reinforcing bars were used as screeds. These bars were set to a level on the rough slab and just before the grout had set, a 1:2 mixture of cement and trap rock was dumped on the floor and screeded off with a straight edge. The mixture was as dry as it was possible to make it and still dump it out of a mixer.

Following this operation and just before the time when the topping material was stiffening up, an even coating of graded trap rock was spread over the entire top to a depth of perhaps ½ or ¾ in. After the topping material had stiffened the dry trap rock was rolled into the surface with a 150-lb. roller made of the same material as the top mix. This roller was operated longitudinally and laterally until the entire area under construction had been rolled. The floor was then rolled with a 900-lb. roller which required two men to operate, and last of all with an 1,800-lb. roller rolling not only laterally and longitudinally but also diagonally. This last roller brought up some water and fine material to the surface. As soon as possible after rolling the floor was given by hand a steel trowelling to smooth out any of the stone that had been up-ended by the rolling processes. Twelve men on the trowelling operation were able to finish about 15,000 sq.ft. of floor in two hours.

As a final operation the floor was surfaced with ordinary grinding machines, with small carborundum blocks and coarse powdered emery. A copious supply of water was necessary in order to make the grinders operate satisfactorily. The grinding operation was started from four to seven days after the topping had been placed. The finished top was 1 in. thick.

The trap rock aggregate was evenly graded from material passing a ½-in. ring up to material passing a ¾-in. ring. It was remarkably free from dust owing to the fact that the companies who supplied the stone carried on their operations under cover. The stone was dry when it arrived at the job.

The entire operation from picking the rough slab to turning over the finished floor cost 16 cents per square foot with finishers at $1.10 per hour and concrete laborers at 75 cents. This cost includes plant charges, power and all overhead.

In order to ascertain the best type of floor to be used under the severe traffic conditions, Mr. Nichols devised a machine consisting of a central vertical shaft driven by a worm gear and motor having attached to the shaft a spider consisting of four arms, each one in turn having at its extremity a box running on a single two-wheel truck, the wheels being of steel 5 in. in diameter by 1¼ in. face. The machine revolved fifteen times a minute. The total loading in the four boxes was about one ton. Granolithic floor of the best approved type without treatment was destroyed in about 5 minutes. Several sections of granolithic treated with surface hardeners lasted a few minutes longer. The type of floor which is described above withstood 30 hours of continuous wear test without appreciable wear. The tests were carried no further, as it was obvious that this type of floor would give better service than any other known type.

The building is occupied by a large shoe manufacturing plant. The heaviest wear on the floor comes at three points, the first where trucks carrying sole leather are in continuous operation during the entire working period over a trucking aisle about 15 ft. wide and 100 ft. long; the second at elevator doors where heavily-loaded trucks, both of the box and stevedore variety, are pushed off the elevators over metal thresholds upon the floor; and the third, and perhaps worst, where tacks dropped from lasting machines are being continuously ground into the floor surface by loaded trucks and the feet of workmen. In none of these places does there appear to be any serious amount of wear and in no case is there any ravelling of the floor. None of the floor finish has broken loose from the sub-floor.

Mr. Nichols states that the best quality maple mill floor lasts only one to one and one-half years under their type of operation. Another noteworthy item is that the floor after grinding is so smooth that trucks do not have the usual heavy rumble in riding over it, yet there is sufficient roughness so that the floor is not dangerous to workmen in leather shoes.

In one section of the factory where a great deal of wax is used, the floor has become as slippery as glass. In the office section, the floor was treated with one of Toch Brothers' compounds, giving it the color of battleship linoleum, a most pleasing appearance.

State Drainage Survey of Indiana

A complete survey of drainage conditions and drainage projects in Indiana is being made by the division of engineering of the State Department of Conservation. Inquiries have been sent to all county drainage commissioners for information as to the officers, areas and outlet streams of projects in their respective counties, together with the names of engineers and contractors. In addition, representatives of the Division of Engineering are visiting all county seats to inspect court and surveyors' records. From these records they plot on county maps the boundaries of the drainage districts and make notes of land values, assessment, cost of construction and the adequacy of the several projects. Codification and revision of the tangled drainage laws is now being made by a commission appointed at the last session of the Indiana legislature, and this commission is working in co-operation with the Division of Engineering.

Shrinkage and Temperature Changes In Reinforced Concrete

A Preliminary Study Based on Some Strain-Gage Observations Made on a Reinforced-Concrete Bridge at Fairmont, W. Va.

By E. H. Harder
Concrete-Steel Engineering Co., New York City

In an article describing the Monongahela River Bridge in Fairmont, W. Va. (*Engineering News-Record*, Sept. 22, 1921, p. 472), the writer briefly mentioned that extensive strain-gage measurements had been made at the crown and haunches of two of the large arches. At the time that article was written the results of these measurements were not available, but the writer did hint that the steel stresses were higher than usually computed. It is not the purpose of the present article to discuss these tests in detail because the results are still indeterminate, largely because of lack of knowledge of the action and effect of shrinkage together with the action and effect of two materials in combination expanding and concentrating according to different coefficients of expansion. The writer merely wishes to present several carefully computed examples taken from the mass of data accumulated and to draw the necessary inferences from these to stimulate research work dealing not only with the secondary stresses of reinforced-concrete structures but also the primary stresses due to shrinkage and temperature changes.

While this article deals mainly with shrinkage of the concrete, it is necessary to inject temperature changes

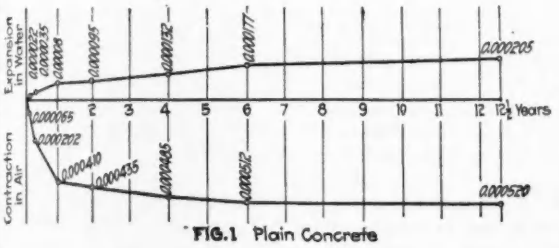


FIG. 1 Plain Concrete

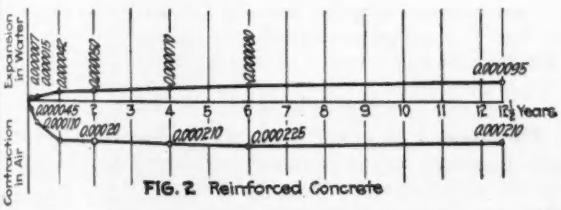


FIG. 2 Reinforced Concrete

FIGS. 1-2—COEFFICIENTS OF EXPANSION OF PLAIN AND REINFORCED CONCRETE PRISMS

From tests made by Graf and Bach. Fig. 1 (above) on plain prisms; Fig. 2 (below) on reinforced prisms.

into the discussion because both produce internal stresses in reinforced concrete which are closely related.

Without going into detail regarding the actual strain-gage measurements, it is necessary briefly to acquaint the reader with the *modus operandi*. Several bars at the extrados were exposed sufficiently to permit the introduction of the points of a 20-in. Berry strain gage into gage holes drilled into these bars. The two outside bars at the intrados were also exposed. Across each face of the arch at the crown as well as over the top, concrete gage lines were established by inserting two brass plugs about 5 in. long and 20 in. apart. Figs. 4 to 7 give the vertical spacing of these gage lines on the arch faces. Readings were taken in the usual manner and compared with readings on a standard bar of steel. A mercury thermometer gave the temperature of the standard bar while mercury and electric resistance thermometers gave the temperature of the concrete. At the haunches, similar arrangements were made to obtain the deformations occurring at these points.

The coefficient of expansion of the steel standard was not measured, but the usual figure 0.0000065 was used throughout. At first we attempted to reduce the strain-age readings for concrete by assuming the same coefficient of expansion but it was soon discovered that 0.0000055 gave results for concrete more nearly comparable with calculated results. It is doubtful if this coefficient is the correct one for green concrete and the writer feels the need of better information regarding the variation of the coefficient with time. Such data would have little bearing on design work but in attempting to interpret the strain-gage readings in question, such a curve would have been invaluable.

FIG. 3—NON-UNIFORM SHRINKAGE

Primary and Secondary Shrinkage Effects—When these tests were planned, it was our desire to check the theory of arches so far as thermal changes were concerned. Others had checked the theory so far as external forces influence the stresses, but the field of temperature stresses was practically unexplored. While we realize the importance of shrinkage we felt that we could obtain the secondary stress effect of shrinkage closely enough by carefully measuring the crown deflections, but in this connection, we did not clearly realize at the start of the tests that shrinkage would be manifested in still another way. Therefore, for the purpose of discussion, the writer has divided the effects of shrinkage into a primary effect and a secondary effect. By secondary effect is meant that stress developed at any section of a monolithic structure due to deformations which in turn are caused by shrinkage. By primary effect is meant that stress produced in the steel as well as the concrete by virtue of the fact that the latter shrinks or expands while the former possesses no such properties.

The primary stress effect of shrinkage of a bar of plain concrete resting on the laboratory table and hardening in air would not be measurable by means of the strain gage. This instrument would merely record a change of length which could only occur by some internal rearrangement of the various particles of the concrete, thereby causing local and internal stress. It is not the writer's purpose even to attempt a discussion of these stresses, since their nature is speculative and perhaps structurally unimportant. If our bar of concrete is reinforced by the introduction of a steel rod, we are enabled by means of the strain gage to record the changes of length in both the concrete and the steel. As the concrete contracts or shrinks, the steel rod is put into compression, while at the same time the concrete is put in tension due to the fact that the steel prevents a free shrinkage of the concrete. These stresses are herein termed primary stresses due to shrinkage.

Mathematically, this compressive stress in the steel may be written:

$$f_s = \frac{1}{1+np} E_s . e$$

and the tension in the concrete

$$f_c = \frac{p}{1+np} E_s . e = p . f_s$$

where n = ratio of moduli of elasticity of steel to concrete;
P = ratio of steel area to concrete area;
E_s = modulus of elasticity of steel;
e = coefficient of shrinkage of plain concrete.

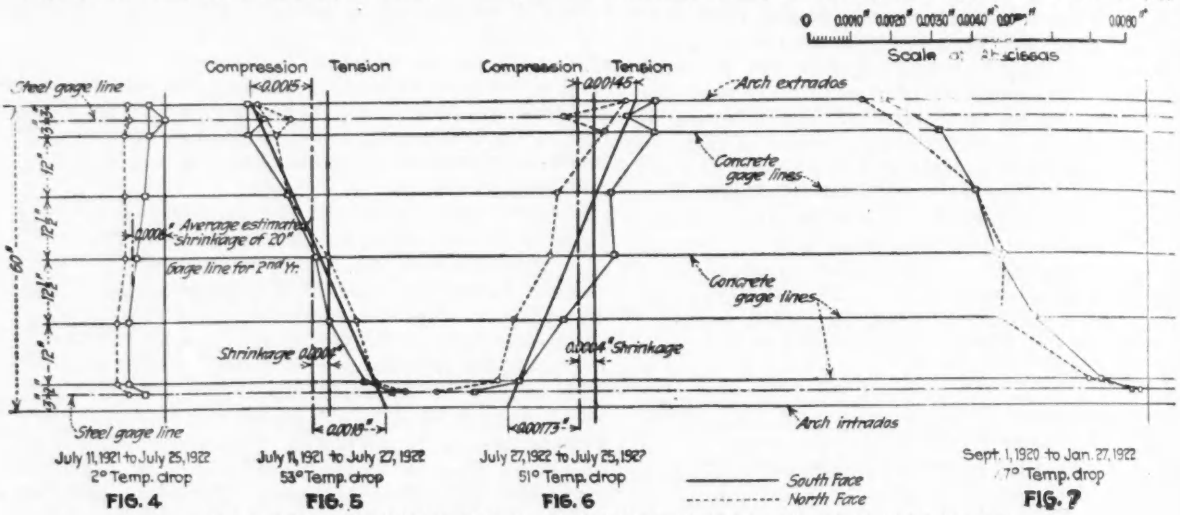
These equations may be true for concrete test specimens of small cross-section reinforced with a relatively large bar since their derivation depends upon the assumption that the shrinkage of the concrete is uniformly restrained over its cross sectional area, but for large sections these relations give results widely divergent from those of a few tests recorded by recent investigators.

Some Earlier Tests—So far as the writer knows, experimental data throwing any light upon these questions are very meager. Emerson (*Engineering News*, March 10, 1904, p. 222) measured what he termed the initial stresses of steel in concrete, but his investigations did not extend beyond a time interval of 84 days. The tests show a difference of these initial stresses for 1:2:4 and 1:3:6 concrete which is to be expected, but it is interesting to note that crushed stone aggregate gave lower initial stresses than did gravel concrete of the same mix.

Perhaps the most interesting experiments touching upon the difficulties involved in our problem are those of Bach and Graf. Four concrete prisms 39.37 in. long (one meter) having a section area of 62 sq.in. were made without reinforcing, and four similar prisms were reinforced by a single bar (0.49 sq.in. area) in the axis of the prism. The mix was 1:3:2. After hardening for several days packed in wet cloth, two prisms of each set were allowed to harden in air and the remaining prisms were immersed in water. The shrinkage measurements covered a period of twelve years and six months, and are shown graphically in Figs. 1 and 2.

The length of the prisms hardened in the air contracted 0.225 mm. (equivalent to 0.000225 in. per in. of length) in 6 years. With a modulus of elasticity of 30,000,000 for steel, the unit compressive stress in the reinforcing bar is 6,750 lb. per square inch. This compression produced a tension in the concrete which was greatest adjacent to the steel and decreased toward the edge of the section. Furthermore, in such a test specimen, there is a further decrease of this tension in the direction of the axis of the prism as the outer ends of the same are approached.

The average total compression in the steel was 6,750 × 0.49 = 3,310 lb. With a modulus of elasticity of 3,550,000 for concrete, this compression would cause a shrinkage of 0.00015 in. per in. or a total of 0.015 mm. in the length of the prism (1 m.). According to Figs. 1 and 2, the difference in shrinkage at the end of 6 years between the plain and the reinforced specimen was 0.512 — 0.225 mm. per meter or almost twenty times the shortening caused by a compressive force of 3,310 lb. if this force were uniformly distributed over the entire section of the prism. It is obvious therefore that the shrinkage over the section is not uniform but increases toward the outer edge of the section, as shown in Fig. 3. Actual measurements showed a difference of 0.38 mm. between the shrinkage at the steel bar in the center of the section and a point 4 in. away in a time interval of 1,723 days.



FIGS. 4-7—COMPARATIVE READINGS OF STRAIN GAGES ON FAIRMONT BRIDGE

Experiments at Fairmont—Referring now to the experiments on the Fairmont bridge, Fig. 4, two dates were selected approximately one year apart and for which the temperatures of the arch were practically the

The latest data on shrinkage of plain as well as reinforced concrete are to be found in Bulletin No. 126, University of Illinois, entitled, "A Study of the Effect of Moisture Content Upon the Expansion and Contraction of Plain and Reinforced Concrete," by Torata Matsumoto. The tests on reinforced-concrete specimens are akin to those by Emerson and show clearly the primary stresses in both steel and concrete. It is also quite evident that the measured steel and concrete stresses are average stresses over the cross-section of the specimen and give no clue to the variation of shrinkage away from the reinforcing toward the outer edge of the section. It is data of this latter nature which are desirable to reduce long time strain-gage readings.

same. The average temperature of all the thermometers was taken for each date and between July 11, 1921, and July 25, 1922, the difference between these averages was approximately 2 deg. F. The stress effect of such a small difference of temperature is not measureable with a Berry strain gage so that the deformations as plotted to the left of the vertical line in Fig. 4 represent the primary effect of shrinkage. The average shrinkage as estimated from these curves for a 20-in. gage line is 0.0008 or equivalent to a temperature drop of 7.3 deg. F. By checking this equivalent temperature drop from deflection data, we obtained 9.3 deg. F. For this small shrinkage during the second year, the primary stress effect is not very marked. However, the deformation of the steel gage line clearly shows the resistance to shrinkage as offered by the reinforcing. The secondary stress effect is too small to be accurately measured by the means employed. At the extrados, the steel deformations are shown conventionally by the apex of the triangle and had the extreme fiber at the intrados been measured, the lower steel deformation would have been shown by the same convention. The curves showing the various deformations are not so ideal as one might wish, but the reader must remember that measuring slight deformations with a portable strain gage while standing 90 ft. above the river is not a simple matter. Besides, the operator had to continually battle with dust and at times with cinders and soot from the locomotives below.

Referring next to Fig. 5, the two dates selected are July 11, 1921, to Jan. 27, 1922, approximately a time difference of six months. The deformations were plotted from the full vertical line with due regard to the sign for each gage line, i.e. — for compression and + for tension. As thus plotted, the deformations over the comprehensive area of the arch are too great by the amount of the shrinkage, while the tension deformations are too small by the same shrinkage, which is approximately one-half of the estimated shrinkage of 0.0008 for the entire year. The deformations as measured and recorded can therefore be changed to deformations designating stress by shifting the full vertical line (axis of ordinates) to the left by 0.0004 in., because this shrinkage has no stress effect other than a small primary effect, so that the vertical dot and dash line now becomes the true axis of ordinates. The full sloping line represents the deformation curve as computed according to approved methods for a drop of 53 deg. F. and in accordance with the computed end abscissas of 0.0015 and 0.0018 inches.

In Figs. 4 to 7, there is a difference between the deformations as recorded for the inner and outer faces of the arch. The reasonable interpretation of these differences is that; first, the transverse girders expand and contract due to temperature changes and due to shrinkage, causing side thrusts and side deflections of the arch, and second, the south face of the rib is subjected to a different exposure from that of the inner or north face. We must, therefore, at least for the time being, be content with striking an average between the two.

Fig. 6 represents the deformations for a temperature rise of 51 deg. F. from Jan. 27, 1922, to July 25, 1922. Again the shrinkage correction has been applied as described for Fig. 5, and the full sloping line gives the computed deformations for a 20-in. gage line and for a rise of 51 deg. F.

Note in Fig. 6, how the deformations of the extrados steel lag behind the concrete deformations which indicate tension, and how the intrados steel deformations project beyond the deformations for the intrados concrete which indicate compression. This is quite reasonable since we know the primary stress effect of shrinkage is to place the steel in compression, thereby reducing the tension in the extrados steel and increasing the compression in the intrados steel. But the amount of this lag and lead seems to have little in common with the indicated pure shrinkage deformations of Fig. 4. The explanation must be sought elsewhere and can be explained on the basis of a difference between coefficients of expansion of steel and concrete. For a slow temperature change from summer to winter there is no good reason for not assuming equal temperatures for steel and its surrounding concrete. The steel wants to expand a length of $20 \times 0.0000065 \times 51$, while the concrete wants to expand a length of $20 \times 0.0000055 \times 51$. The difference between these expansions is really in the nature of a shrinkage of $20 \times 0.000001 \times 51$ or 0.00102 in. The concrete is here holding back the steel and thereby preventing full expansion. Since the average primary or initial compression of the intrados steel due to the shrinkage of 0.0004 is 0.00035 in., the compression for a "shrinkage" of 0.00102 is 0.00088, or a total compression of 0.00123, which agrees quite well with the lead for intrados steel in Fig. 6. The steel deformations for the extrados steel are not so reliable as those of the intrados steel since it was a serious matter to keep the small gage holes free from rust.

Referring again to Fig. 5, one would expect the lead to be in the extrados steel and the lag in the intrados steel because of reversal of stresses. Here, however, we have a drop of 53 deg., which on the same basis as described above would result in an apparent expansion of 0.00106 in. in a 20-in. gage line, i.e., the steel wants to contract more than the concrete and is thereby in tension which is analogous to the tension caused by an expansion of concrete with increasing moisture content. This time we have a primary tension in the steel amounting to 0.00089 in. from which must be deducted the primary compression of 0.00035 in. due to shrinkage or a net tension of 0.00054 in., which again agrees substantially with the curves of Fig. 5. At the same time it is noticeable that the concrete gage lines show the effect of these primary steel stresses due to shrinkage and difference of coefficients of expansion.

Fig. 7 is an example of the deformation curves for the inner and outer faces of the arch from the date of the beginning of the lowering of the arch centering on Sept. 1, 1920, to Jan. 27, 1922. These curves represent the measured deformations as obtained from field notes and are due to full dead-load, a temperature drop of about 47 deg. F. and the unknown and complicated shrinkage factor. It is not the writer's intention to interpret these curves nor does he wish to give the deformations of the extrados steel until he has had opportunities to verify these measurements on other arches. Fig. 7 is merely given to show the reader a sample curve of what may be expected for long time readings. In the interpretation of this last figure, it is first essential to deduct from the plotted ordinates the extent of the shrinkage between the two dates given.

Questions to be Answered — Due to our present insufficient knowledge of the distribution of shrinkage

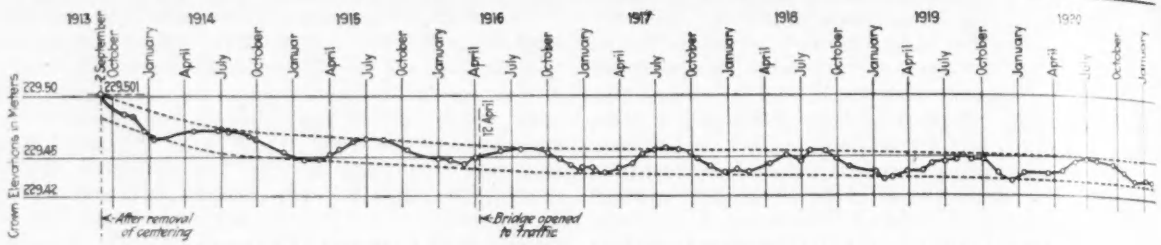


FIG. 8—CROWN DEFLECTION MEASUREMENTS ON NECKAR BRIDGE OVER SEVEN YEAR PERIOD

over a large section reinforced at the top and bottom, the investigator of long time strain-gage readings on reinforced concrete must answer some very vexing questions, before he can properly interpret his results. The leading questions are as follows: How great are the deductions which can be made from the deformation abscissa and which would represent shrinkage not producing stress? In this case, where the shrinkage is large compared with that of Figs. 4, 5 and 6, would we be justified in assuming a uniform shrinkage over the entire surface or, if not, to what extent does the steel reinforcing alter these shrinkage deductions? To what extent are the stresses caused by the dead-load plus the secondary stresses of temperature and shrinkage affected by the primary stresses (tension) caused by shrinkage? Are these tensile stresses uniform over the entire section or are they greater in the vicinity of the steel? How has the modulus of elasticity varied between the two dates and how does this modulus vary with varying unit stresses? How large are the stresses caused by the difference between the coefficients of expansion of concrete and steel, and how are such stresses distributed over the section?

Neckar River Bridge Measurements—Data in regard to shrinkage obtained from crown deflection measurements are not applicable because such data can only give us a measure of average shrinkage producing secondary arch stresses. Fig. 8 shows an interesting curve of crown elevations covering a period of seven years. The bridge in question is a three hinged plain concrete arch across the Neckar River at Cannstadt. During a period of seven years from the time the centers were struck, the crown of this 187-ft. span dropped 2 in. due to shrinkage. In Fairmont similar conditions prevail and in two years' time from the dropping of the arch centering, the crown of the center span dropped about ¾ in., which is less, in proportion, than for the Neckar bridge during the first two years. The fact that the Fairmont arches are hingeless as well as reinforced accounts for this difference, likewise the shape of the arch, radial thickness, etc. The coefficient of shrinkage as estimated for the Neckar bridge is 0.00041 after seven years. Some European specifications call for a shrinkage stress provision by using a shrinkage coefficient of 0.00025, which is equivalent to a temperature drop of 38 deg. F. These specifications permit a reduction of this equivalent temperature drop to 18 deg. F., provided the arch is built with keyways and provided that the keyways are concreted not less than 14 days after the last section is poured. From a consideration of all shrinkage data available and from our experience with the Fairmont tests, the writer fails to find any justification for such a reduction of 20 deg. equivalent temperature drop because the time interval of two weeks is too short.

There is so much room for research work in the investigation of primary and secondary stresses in reinforced concrete—both on test specimens and completed structures—that it is difficult to mention a point of beginning, and impossible to see the end. Not only does shrinkage vary with time, and quantity of cement per unit of concrete, but it varies with different brands of cement. Just which constituents of the cement are responsible for this shrinkage are still imperfectly understood. Strange to say, shrinkage also varies with different kinds of aggregate. Since the writer believes that the long time strain gage tests partially described in this article are the first of their kind, it is his hope that others will be stimulated to make similar tests or to make known through the technical press the results of such tests that have been made. Such work will show whether or not shrinkage is really the important factor it now seems to be and may stimulate research in the chemical field to produce a cement with a very small shrinkage coefficient. From present knowledge of this phenomenon, it would seem that a non-shrinking cement is of more importance than the attempt to produce a super cement of high tensile or compressive strength.

Sir Henry Thornton Pays Tribute to U. S. Railway Work in France

Speaking at the annual banquet of the Pittsburgh Traffic Club recently, Maj.-Gen. Sir Henry Thornton, president of the Canadian National Railways, and during the World War deputy director-general of movements and railways for the British armies, paid high tribute to the work of the American railway transport service in France during the war. General Thornton had opportunity to judge of the mettle of the railway troops not only by the results they achieved but also by contact with them while in action. He said:

I have long wished an opportunity to express publicly the admiration which those who were employed in the British Transport Service felt for our American allies, and the successful way in which they met the serious transportation difficulties which confronted them in France. I have also hoped upon some occasion to pay my humble tribute to the skill and the energy of your railway department. There has been an unmerited silence upon this subject.

The people of the United States know little the debt they owe to the genius of their railway officers who perfected and administered the wonderful American transportation in France. Much has been said, and properly so, of the magnificent work of the soldiers in the trenches, the officers who commanded them. Much has been said in praise of fighting generals and the anxieties they must have experienced; many other services have received their just and merited praise, but I am here to say that none of those would have had even an opportunity to perform their service had it not been for the efficiency of the American transport department, which day by day kept the front supplied with food, explosives, munitions and all of those things which enter into the conduct of a great war.

Winds and Barometric Effects on the Great Lakes

By John F. Hayford
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Research Associate, Carnegie Institution of Washington, D. C.

TO SECURE a much better formulation of the laws governing evaporation and stream-flow than is now available to the engineering profession is the ultimate object of the extensive investigations of which certain phases only are reported upon in this article. It appeared at the outset that maximum effectiveness in securing this ultimate object would probably be obtained by first investigating evaporation as it takes place on the full scale of nature at the surface of the Great Lakes and then applying that knowledge to the study of stream flow. It is believed that the Great Lakes, each to be considered in turn as an evaporation pan, furnish the most promising opportunity in the world for such a full scale study of evaporation. The surrounding conditions are extremely favorable. The pertinent meteorological and hydrographic data have been recorded in considerable detail for many years by the U. S. Weather Bureau and the U. S. Lake Survey.

This article is essentially a condensation of a volume of 133 pages by the same author and under the same title which has recently been issued as Publication 317 of the Carnegie Institution of Washington. That Institution has since 1911 supported the extensive investigation, which is still in progress, of which this report covers a part only. Some of the statements in this article are based on developments in the investigation since Publication 317 was prepared for the printer.

It gradually became evident, in the attempt to determine the change of total content from day to day of one of the Great Lakes with sufficient accuracy to isolate the evaporation, that it was necessary first of all to determine the effects of winds and of barometric pressures on the Great Lakes. The investigation was therefore concentrated on those effects. They are now understood and may be computed with the requisite accuracy. This part of the investigation is complete. The direct study of evaporation and stream flow, based upon this knowledge, is proceeding.

A large amount of data has been used to date in this general investigation. Certain parts of the investigation depend upon hourly observations of the winds and hourly observations of the water surface during from thirty-four to fifty-two days at each of the five stations, Buffalo, Cleveland, Milwaukee, Mackinaw and Harbor Beach. Other parts depend upon daily means of the elevation of the water surface for eight months at each of the five stations named, and also at Marquette on Lake Superior, and upon barometric pressures as regularly observed at many stations around the Great Lakes twice a day by the U. S. Weather Bureau.

The facts have been intensively studied. Up to September, 1921, more than 24,000 man-hours of time had been spent in this investigation, under the auspices of the Carnegie Institution.

How Problem Was Attacked—It appeared at the outset that there were several different factors or influences operating simultaneously to cause fluctuations of the elevation of the water surface at a gage, no one of which could be safely neglected while attempting to evaluate others. This led to the adoption of the least-square method of computation for the investigation, since it is in just such cases that this method has the maximum advantage over all other methods.

In the broader investigation of evaporation, including the investigation of wind effects and barometric effects which is here reported, seventy-four least-square solutions and the corresponding studies had been made up to September, 1921. Typical solutions each contained from 100 to 600 observation equations, each having for its absolute term the observed change in elevation of the water surface at a gage during a day or an hour, and each containing from two to eight unknown constants to be determined.

In general the order of procedure has been (1) to study the particular problem in hand in the light of all available evidence and to develop a theory as to the relation of the different quantities involved, such as, for example, the change of elevation of the water surface at a gage, the direction and velocity of the wind, the distribution of barometric pressure over the lake, the temperature, humidity and recent rainfall; (2) to express that tentative theory (or a part of it) in the form of a general equation and set up the corresponding observation equations for a least-square solution to test the validity of the theory; (3) to make the least-square solution and thus secure a set of computed values of the unknowns, assumed to be constant, which are supposed in said theory to express the relations between the observed quantities, and also to secure a set of residuals which are the discrepancies between the tentative theory and the observed facts; (4) to study the outcome of the least-square solution in the light of the internal evidence of the solution; (5) to study the outcome of the least-square solution in the light of all the available external evidence, such as might be furnished, for example, by comparisons with other independent least-square solutions and with evidence entirely independent of such solutions; (6) to develop an improved theory with the benefit of all the light gained from steps (1) to (5) inclusive and then to repeat all of the processes (2) to (5) inclusive, upon a new least-square solution based either upon the same data as before, or the same data together with added data, or upon entirely different data for other times and places. The whole cycle (2) to (6) was carried through once for each least-square solution made.

The last few paragraphs indicate why it can be said with sincerity that in this investigation a large collection of carefully observed facts have been intensively and extensively studied. The conclusions are believed to be correspondingly reliable.

Results—The outcome of the investigation to date may be very briefly characterized as follows:

(1) Reasonably accurate numerical expressions have been obtained for the effects of barometric pressures on the elevation of the water surface at the six stations, Buffalo, Cleveland, Milwaukee, Mackinaw, Harbor Beach and Marquette, on Lakes Erie, Michigan, Huron and Superior. With these expressions one may, from the distribution of barometric pressures ordinarily shown on the forecast maps of the Weather Bureau, compute the disturbances in elevation of the water surface thereby produced at the stations named.

(2) The general method has been developed by which such a numerical expression for the barometric effect at any station on any body of water may be derived from observations of the water elevation at that station and the forecast maps for the same period.

(3) A general expression, including the necessary numerical constant, has been obtained for the effect of winds of any given velocity and direction in producing a disturbance of elevation of the water surface at any given station on any body of water anywhere in the world. The data required in regard to the station and the body of water are such as are ordinarily shown on good charts, namely, the depths of the water at all points, the location of the shore line and the location of the station.

(4) Three of the prevailing seiches, or free oscillations under the influence of inertia, on Lake Erie have been isolated. Their periods and probable methods of oscillation

have been shown. The relation between these seiches and the uncertainties in daily mean elevations of the water surface at gage stations has been discerned. The appreciation of this relation aids decidedly in obtaining accurate determinations of the daily mean elevation of the mean surface of each lake.

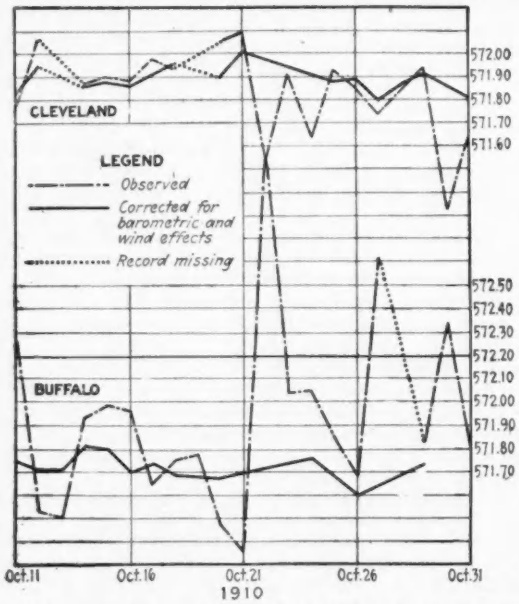
(5) The accuracy with which the elevation of the mean surface of any one of the Great Lakes may be determined for any given day has been decidedly increased.

When one determines the fluctuation of elevation of the mean surface of a lake he thereby determines the fluctuation in the total water-content of the lake.

The progress made in determining the evaporation from the surface of the Great Lakes is not yet sufficiently great or certain in character to warrant a definite statement here.

Six Fluctuations—On any one of the Great Lakes at any time there are six fluctuations of the surface of the water in progress, namely, ripples, wind waves, tides, wind effects, barometric pressure effects and seiches.

The ripples and wind waves are visible and familiar. Imagine them to be entirely smoothed out at each instant



LAKE ERIE WATER SURFACE OCT. 11 TO 31, 1910

As observed and as corrected for wind and barometric effects. The apparent fluctuation of 0.76 ft. at Cleveland and 1.69 ft. at Buffalo smooth out into fairly continuous graphs when corrections are made.

by putting the water from each ripple crest and wave crest into the adjacent troughs so that the surface would appear to the eye to be smooth and level. Such a lake surface with ripples and wind waves eliminated would never be level except by accident. That smoothed surface would be subject to tides, to wind effects, to barometric effects and seiches.

It is the elevation of that smoothed out surface at the gage which is actually recorded by an automatic gage, such as was used at each of the six observation stations. The water in the still well of the gage is connected with the water outside through holes so small that the separate waves and ripples outside produce no appreciable change in the elevation of the surface of the water in the still well. The gage therefore records at any instant substantially the mean elevation of the outside water surface, during the past minute, or the past few minutes, not its instantaneous elevation.

The tides on the Great Lakes, having a range of less than 2 in. as a rule, may safely be ignored in this investigation.

Lake Slopes—The smoothed out lake surface, from which ripples and visible wind waves have been eliminated by assumption, is not level at any time on any one of the Great Lakes, except by accident. It is always disturbed by wind and by barometric pressures. But the slope in that surface is always and everywhere too small to be visible to the unaided eye. Anywhere on the Great Lakes where the depth of water is as much as 10 ft. and under the most extreme conditions of wind and barometric pressure such slopes are probably not greater than 0.011 ft. vertical to 1 mile horizontal. The slopes of the character referred to in this paragraph persist with one sign for many hours, as a rule, and sometimes for several days, until the wind changes or the barometric conditions change.

It is these long continuous invisible slopes of the water surface produced by winds and differences of barometric pressure that cause the recorded mean elevation, for any hour or any day, at a gage, to be different from the actual mean elevation of the whole surface of the lake for that hour or that day. The difference between the mean elevation of the water surface at a gage for any hour or any day and the mean elevation of the whole lake surface during that time is the combined wind effect and barometric effect.

A uniform increase or decrease in the barometric pressure over the whole of a lake has no influence on the position of the water surface. But if the barometric pressure becomes smaller over one part of the lake than it is over any other part, then the water tends to move from the region of the high pressure toward the region of low pressure.

Equilibrium would be established when the decrease in relative barometric pressure in the region of low pressure has been compensated by an accumulation there of an extra layer of water just equivalent to the relative defect in barometric pressure. In the condition of equilibrium the slope of the water surface is upward towards the region of the barometric low.

Barometric Effects Evaluated—The isobars, lines of equal barometric pressure, over any one of the Great Lakes, are continually changing, just as the barometric pressures over all other parts of the continent are continually changing. So the position of equilibrium of the water surface of any one of the Great Lakes as subjected to the influence of the barometric pressures is continually changing. The investigation shows that in general there is a moderate lag (about three hours upon an average) in the response of the water surface to a changed distribution of barometric pressures and that in general the water after having been put in motion toward the position of equilibrium is carried past that position by inertia, thus making the actual barometric effect greater than that corresponding to equilibrium. For six stations on the Great Lakes, Buffalo and Cleveland on Lake Erie, Milwaukee, Mackinaw and Harbor Beach on Lake Michigan-Huron and Marquette on Lake Superior, the barometric effects have been evaluated. For these stations, given the barometric gradients over the lake at any time, the effect of the barometric pressures in disturbing the water level—that is in making it higher or lower at the station than the mean elevation of the whole lake surface—can be computed with reasonable accuracy.

The error in the computed mean barometric effect on any given day at a station is probably less than 5 per cent of that effect on about one-half of all the days. The computed barometric effect, as stated later, seldom exceeds 0.20 ft. at any one of these six stations, and is less than 0.10 ft. during much more than one-half of all the days. On a small percentage of exceptional days, at times when the barometric gradients are changing rapidly and irregularly, which is usually when a well developed low pressure area is over or near the lake, the computed barometric effects are subject to abnormally large errors, much greater than 5 per cent. These exceptional days are usually solitary, not in groups.

The effect, E_1, of barometric pressures in making the elevation of the water surface at Milwaukee at any hour greater than the mean elevation of the whole surface of Lake Michigan-Huron is expressed numerically as follows:

$$E_1 = (P_4 - P_5)\ (-4.97) + (P_2 - P_6)\ (+8.44)$$

In this formula E_1 is expressed in units of 0.001 ft. and a positive value means that the water surface at Milwaukee is higher than the mean surface of the whole lake.

The quantity $P_4 - P_5$, a "westward barometric gradient," is understood to be the excess in hundredths of inches of mercury of the barometric pressure at latitude 45 deg. and longitude 87½ deg. over the barometric pressure at latitude 45 deg. and longitude 80 deg., 7 hours earlier than the hour for which the barometric effect is to be computed. The first of the two points named in the preceding sentence is a short distance west of Lake Michigan-Huron and the second is a short distance to the eastward of the lake, so that the line connecting these points is one across the lake from west to east near its middle latitude. Similarly the quantity $P_3 - P_6$, a "northward barometric gradient," is understood to be the excess of the barometric pressure, in the units specified, at latitude 47½ deg. and longitude 85 deg. (a point north of Lake Michigan-Huron) over the barometric pressure at latitude 42½ deg. and longitude 85 deg. (a point to the southward of Lake Michigan-Huron) 4 hours earlier than the hour for which the barometric effect is to be computed. The two intervals, 7 hours and 4 hours, are the lags in the two components of the barometric effect as determined from the observations. The formula enables one to compute the barometric effect at any time at Milwaukee, if the barometric pressures at the points named are known, from the forecast maps of the Weather Bureau or otherwise. The constants —4.97 and +8.44 were determined from the observations by the least-square method of computation.

Similar formulas have been derived for each of the other five stations which have been named. The general method for evaluating the effects of barometric pressures at any station on any body of water has been developed.

At Milwaukee the computed mean barometric effect for a day exceeded 0.19 ft. on 8 days out of 8 months in 1910 and 1911. The maximum was +0.30 ft. on July 25, 1911. On 62 days out of the 244 in these 8 months the barometric effect was 0.10 ft. or greater. At Buffalo the maximum computed mean barometric effect for any day during 8 months in 1909 and 1910 was 0.55 ft. At each of the other four stations of the six which have been named the barometric effects are smaller than at Milwaukee or Buffalo. The maximum computed barometric effect at any hour at any one of the six stations is in general nearly twice as large as the maximum computed mean barometric effect for any day. The maximum barometric effect usually persists for only an hour or two. At Milwaukee for the particular 35 days which have been examined in great detail the maximum computed barometric effect was 0.44 ft. at noon on Sept. 24, 1910.

Wind Effects—It is known that wind drives the surface water to leeward and tends to pile up the water on the lee shore of a lake. It produces a slope upward to leeward on the imaginary smooth surface of the lake to which reference has been made. This has long been known qualitatively.

The research now under consideration has given a quantitative determination of this effect. The slope produced at any point is fixed by the condition that the return current, beneath the surface, to windward, produced by gravity, must return the water to windward at the same rate that it is delivered to leeward by the surface current. Assuming that in the return current under the influence of gravity the relations of velocity, mean hydraulic radius and slope are those expressed by the well known Chezy formula, it follows that after the steady regime has been established for any given wind the slope at any cross-section is inversely proportional to the cube of the mean depth of the water at that cross-section. It was also found from the evidence given by the observations that the slope is proportional to the 2.4 power of the wind velocity.

The necessary constant to reduce these mere proportionalities to definite values has been determined from the observations made at several points on the Great Lakes. There is available now from this investigation a general formula shown hereafter, for computing such wind effects. The formula and its constant are applicable anywhere in the world on any large body of water. That is, given such facts for any body of water as are shown on a chart,—depths, distances, configuration of shore, etc.,—the effect of any wind of known direction and velocity in producing a disturbance of the elevation of the water surface at any point may be computed.

It has been found that the response of the water to the wind is prompt. There is no appreciable lag.

The formula expressing wind effects is

$$W = + 0.088 \left(\frac{h^{2.4}}{100}\right) \Sigma_x$$

W is the effect at a given time of the wind at a given gage station in elevating the water surface at that station above the mean elevation of the whole surface of the lake; h is the velocity of the wind at that station. Σ_x is a quantity appropriate to the station for each wind direction which expresses the relation between the effect of a wind of a certain velocity, on the one hand and the depth of the lake at every point, the shape of the bottom, the horizontal dimensions of the lake and shape of the shore on the other hand. W is expressed in units of 0.01 ft. and h is in miles per hour. The method of determining Σ_x from a chart is too complicated to be set forth here. It is stated in full in the publication by the Carnegie Institution.

The value of Σ_x for each of the eight primary directions of the wind, N, NE, E, etc., for the six stations on the Great Lakes which have been referred to in connection with barometric effects vary from —8.32 for a northeast wind at Buffalo (and +8.32 for a southwest wind) to —0.05 for a southeast wind at Harbor Beach (or +0.05 for a northwest wind). In general the values of Σ_x and therefore the wind effects for winds of a given velocity are largest at Buffalo and smallest at Marquette.

The maximum computed wind effect at any instant within the limits of time covered by the observations used in this investigation at any of the six stations occurred at Buffalo at 10 a.m., Oct. 27, 1910, when a wind of 53 m.p.h. from the southwest caused the water surface at Buffalo to be 1.02 ft. higher than the mean elevation of the whole surface of Lake Erie at that instant. The mean computed wind effect for the whole of that day at Buffalo was 0.22 ft. At Milwaukee in sharp contrast to Buffalo the maximum computed wind effect at any instant within the limits of this investigation was only 0.032 ft. at midnight on Sept. 6, 1911, when a wind of 31 m.p.h. from the east raised the water surface at Milwaukee 0.032 ft. higher than the mean elevation of the whole surface of Lake Michigan-Huron. The mean wind effect for the whole of that day at Milwaukee was only 0.003 ft. At Mackinaw and Harbor Beach the wind effects are still smaller than at Milwaukee. At Marquette the average wind effect is not more than one-half as large as at Milwaukee.

Seiches—Seiches in lakes have long been known. A seiche is an oscillation of the water of a lake under the influence of inertia. The water oscillates with the free period of the lake, or of a portion of the lake, for a considerable time after it has been given an impulse, or a series of impulses, just as a piano wire or the air in an organ pipe oscillates. On the Great Lakes the water is continuously being given impulses by the changing of the wind in direction and velocity and by the changing barometric pressures. Thus seiches are started on these lakes. When once started the water surges past the position of equilibrium fixed by the existing winds and barometric pressures. The water surface oscillates back and forth about the position of equilibrium until the energy put into the oscillation by the impulse or impulses has been dissipated. The study of the effects of winds and of barometric pressures on the Great Lakes has incidentally discovered three of the principal seiches in Lake Erie, shown their periods, determined their manner of oscillation, and in a few special cases it has traced a particular seiche to its initial impulse.

It has been established that the water of Lake Erie frequently oscillates lengthwise the lake in such a way that the surface is high at Cleveland near the west end of the lake when it is low at Buffalo and vice-versa. The period of this seiche is 13.1 hours for a complete oscillation—from high to high or low to low at a given point.

During the investigation it became clear that in the eastern one-third of Lake Erie, a portion which is much

deeper than the remainder of the lake, there is a seiche with a period of 3.7 hours. This portion of the lake oscillates lengthwise.

Near Cleveland there is frequently a seiche in the form of an oscillation back and forth across the lake from Cleveland to the Canadian shore with a period of 2.6 hours.

For engineering purposes one rarely needs to use a unit of time smaller than 1 day in connection with Great Lakes problems. For each day the mean elevation of the water surface is ordinarily taken as furnished by the U. S. Lake Survey, computed by them from twenty-four hourly ordinates read from the gage record, proper instrumental corrections being applied. In general the effects of the 13.1-hour seiche and of seiches of shorter period are nearly eliminated from such daily means. The elimination is thoroughly good, however, only when the seiche is in progress throughout the whole 24 hours with but slight variation in range. Ordinarily a new seiche starts with an unsymmetrical first wave. The mean elevation for the day on which a very large seiche starts tends, therefore, to be considerably affected. The understanding of seiches gained during this investigation has made it feasible even when one is dealing only with the mean elevation for each day, as ordinarily furnished by the U. S. Lake Survey, to detect the particular daily means which are much vitiated by the beginnings of new large seiches. These particular daily means may then properly be rejected from any study or assigned light weight. This outcome of the study of seiches, a criterion for detecting vitiated daily means, has proved to be especially valuable in the investigations of evaporation and stream-flow which are now in progress.

Applying the Corrections—The graphs illustrate the gain made in determining the mean elevation of the whole surface of Lake Erie from observations at Buffalo and Cleveland by applying corrections for the effects of winds and the effects of barometric pressures, and by detecting the particular daily means which are vitiated by new large seiches. The dot-and-dash graphs show observed daily mean elevations, each being the mean of twenty-four hourly ordinates read from a gage and corrected for gage errors. The continuous graph has in each case been obtained by applying to the observed daily mean elevation the computed correction for the effects of winds and of barometric pressures and rejecting by the criterion the particular daily means which were found to be seriously vitiated by new large seiches. Note (1) that the continuous graph (corrected values) is much smoother than the dot-and-dash graph (directly observed values); (2) that although the dot-and-dash graph shows an apparent fluctuation within the 20 days of 0.76 ft. at Cleveland and at Buffalo of 1.69 ft., the continuous graph shows an apparent fluctuation in the same interval of only 0.21 ft. at Cleveland and at Buffalo; and (3) that whereas the dot-and-dash graph shows apparent fluctuations in opposite directions at Buffalo and Cleveland on Oct. 22 (the most extreme case), Oct. 12, Oct. 21 and Oct. 27, there is little if any evidence of such a relation in the continuous graphs (corrected values). These evidences, and much similar evidence from other graphs, indicate the greater accuracy and reliability of the corrected values (continuous graphs) as compared with the directly observed values (dot-and-dash graph) considered as a means of determining the mean elevation of the whole surface of Lake Erie. In connection with comment (3) note that the mean elevation of the whole surface of Lake Erie cannot change in opposite directions at the same time. To bring out the full force of comments (1) and (2) it should be stated that a consideration of the external evidence as to rainfall, runoff, evaporation, inflow from the Detroit River and outflow through the Niagara River shows it to be reasonably certain that on no day during the 20 under consideration did the mean elevation of the whole surface of Lake Erie change as much as 0.03 ft. in either direction. All apparent fluctuations in one day in excess of that amount are evidences of error. The continuous graphs conform much more closely to the degree of smoothness required by this criterion than do the dot-and-dash graphs.

From all the evidence, and more particularly from the careful numerical studies, it is clear that the present understanding of wind effects, barometric effects and seiches, used as it has been in this investigation, enables one to determine the mean elevation of the whole surface of Lake Erie as accurately from a single day of observation at Buffalo as it could formerly be determined from 16 days of observations. On Lake Michigan-Huron the wind effects and the seiches are much smaller than on Lake Erie and hence the relative gain secured by taking account of them is smaller. Nevertheless the evidence shows that the mean elevation of the whole surface of Lake Michigan-Huron may now be determined as accurately from a single day of observation at Mackinaw as it formerly could be determined from 6 days of observation.

A large increase has thus been secured in the accuracy with which the fluctuations in total water content of each of the Great Lakes from day to day may be known.

Economic Importance of New-Found Accuracy—The following statements suggest why the increase in accuracy which has been secured is needed in connection with other engineering problems of large economic importance, which have arisen in connection with the Great Lakes. A sheet of water 0.01 ft. thick covering Lake Erie contains 2,800,000,000 cu.ft., is equivalent to the whole outflow into the Niagara River under typical conditions for about 3.7 hours and would develop about 10,500,000 kw.hr. of energy if it were utilized in a good hydro-electric generating station having an effective head of 200 ft. such as is available at Niagara. At 2c. per kilowatt hour this amounts to $210,000. The whole controversy which has already extended over many years, between the navigation interests backed by the United States on the one side and the Sanitary District of Chicago on the other side has turned upon a question of a few tenths of a foot only, as to the elevations of the lake surface as compared with what they would have been if no Chicago drainage canal had ever been built, or if somewhat less water had been allowed to run through it. According to the ultimate outcome of this controversy Chicago may be forced to spend many millions of dollars in works for sewage treatment, or the controversy may be settled by much less costly regulation of the Great Lakes for the joint benefit of navigation, power development and sanitation. It has been estimated, and the statement published with a statement of its basis, that a lowering of the lake levels by 0.1 ft. causes an annual loss of revenue to vessel owners of $590,000, which loss must be made good by an increase in rates. (See Diversion of Water from the Great Lakes and Niagara River, p. 390, Government Printing Office, 1921.) That is, a gain of 0.1 ft. in depth in the Great Lakes would be worth more than one-half million dollars per year to the people of the United States.

In estimating the importance of applying corrections for the effects of winds and of barometric pressures it is important to note that these corrections sometimes remain of the same sign for several days at a time. For example, the corrected mean elevation for the whole surface of Lake Erie for the 5 days, July 21 to 25, 1910, is 0.14 ft. less than the observed mean for that period. That is, the mean correction for the effects of winds and of barometric pressures for these 5 days is —0.14 ft. The correction for these two effects remained so persistently negative for 26 days at this time that for the whole period the mean correction was —0.07 ft. For October, 1909, the mean correction for the whole month was —0.09 ft. That is, if one neglected the corrections for wind and barometric effects for October, 1909, thereby ignoring the fact that the lake surface had a persistent slope in one direction during all of that period he would reach a conclusion that is in error by nearly 0.1 ft. even though he had used the mean of the two stations, Buffalo and Cleveland. At Milwaukee the corrections for the effects of barometric pressures were positive on every day from July 8 to July 30, 1911, inclusive. The correction was greatest on July 25, namely, +0.30 ft. Its mean value for this period of 23 days was +0.11 ft. Without a knowledge of the necessary barometric corrections one is thus misled by the Milwaukee record by more than 0.1 ft. for more than 3 weeks, in so far as the mean elevation for the whole surface of Lake Michigan is concerned.

Precast Concrete Units Used For Relining Railroad Tunnels

Ribs Placed in Halves by Special Crane With Universal Jaw—Cost Said to Be Less Than Usual Methods of Lining

A METHOD used in replacing the timber lining of Redwood Canyon tunnel on the San Francisco and Sacramento R.R., just outside the city of Oakland, Calif., employs concrete ribs and slabs which are cast outside the tunnel, brought in on flat cars and placed by a crane designed especially for this work. Timber lining put in this tunnel when it was constructed in 1912 became weakened by age and seeping water and the problem was to replace the lining without traffic interference.

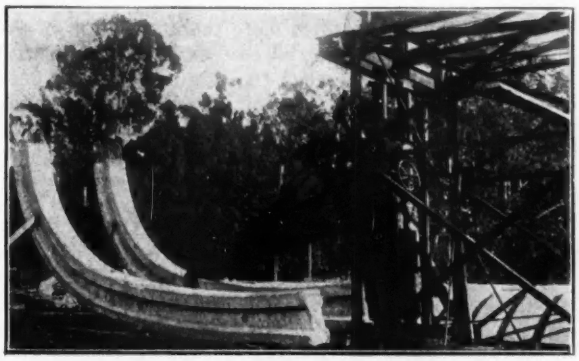
Under the present construction program it is possible for the work train to remain in the tunnel for only a few hours each day in the early hours of the morning as the use of the tunnel tracks at any other time would interfere with regular train schedules. This is not a drawback with the precast unit method, however, because the worst spots are given attention first.

The nearest suitable casting yard that could be located on railroad right-of-way was 6 miles from the tunnel. Here ribs and slabs are cast on built-up wooden platforms, with the aid of removable metal side forms. The mix for both ribs and slabs is 1 part of cement to 6 parts graded sand gravel and crushed rock.

Each half-rib weighs 5 tons and is made to conform to a curve that gives the tunnel a width of 16 ft. and a height of 22 ft. inside the concrete. The rib cross-section resembles that of an I-beam with a thick web; in the plane of the arch the ribs are 24 in. thick, the width being 8 in. and 14 in. in the web and flange respectively. The groove on either side of the rib formed by the web-and-flange construction serves to hold the slabs that take the place of lagging and close the space between the ribs when in final position. Each rib is reinforced heavily with ¾-in. corrugated steel bars.

After remaining on the casting forms long enough to allow ample time for curing, the ribs are loaded by the yard crane onto flat cars equipped with racks or cradles taking four ribs per car. Each half-rib is cast with reinforcing bars projecting at the upper end for bonding into the keystone of the arch which is cast in the tunnel so as to unite each pair of halves after they have been set in place. Before pouring the ribs transverse

RIBS ON WOOD PLATFORM IN CASTING YARDS
Metal side forms have been removed. Note three holes in web used for lifting and placing.



SPECIAL CRANE IN POSITION FOR LIFTING RIB
Jaw on boom end is clamped to rib by bolt through web. Universal joint just behind jaw aids in accurate placing in tunnel.

wood pins are placed in the form to provide three holes through the web of each half-rib. Two of these are for the chains by means of which the rib is picked up from the forms and loaded onto flat cars; the third is at the center of gravity of the rib and is used by the claw or clamp with which the rib is placed in final position.

A crane adapted to handling the ribs in the limited clearance inside the tunnel, and shown in the accompanying illustration, was designed expressly for this job. It consists of a well-braced structural steel frame, mounted on a flat car, and operating an L-shaped boom. The boom has at its outer end a claw and a universal joint. These make it possible to lift the rib from the car and adjust it to any position that may be required in setting it accurately in place where it is fastened securely before the crane lets go. As now organized, the work of setting and securing each rib in place occupies from fifteen to thirty minutes.

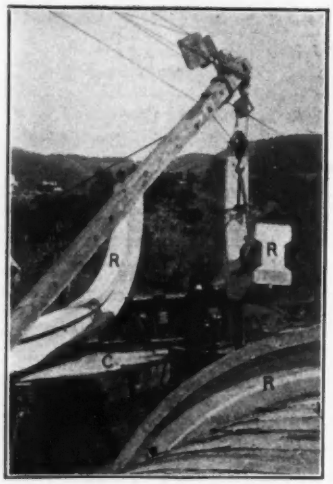
Formerly the claw consisted of a detachable clamp bolted to the ribs as they lay on the car. To this claw the end of the crane boom was attached by means of a pin. More recently a new jaw has been devised which is expected to greatly facilitate and speed up the work. The new jaw combines the clamp and the universal joint in a single device which is not detached from the crane.

When a pair of half-ribs is lined up in final position, a rigid, box-like steel form is fastened at the crown of the arch in such a way as to hold the upper ends of both ribs firmly until the concrete poured into the form to make the keystone of the arch has had time to harden. Prior to placing the ribs concrete sills are poured as a footing and, where necessary, a concrete invert or struts beneath the track is also put in.

The slabs between the ribs do not have to be put in immediately after the ribs are placed. Some 600 ft. has been left without any slabs, the old wood lagging being allowed to remain. As the ribs are ordinarily spaced 3 to 4 ft. apart, this has been found to serve very effectively. Where slabs have not been put in, a longitudinal tie between successive ribs is grouted in place along the crown of the arch. Slabs are 10 in. high and weigh about 100 lb. each; they are brought into the tunnel on flat cars and a small jib crane is used to facilitate placing them. When in place the slabs are grouted with a mixture 1 part cement to 2 parts sand.

Timbering in a part of this same tunnel was replaced by concrete lining poured continuously in the ordinary manner, the work being done with the same labor and under the same general conditions as when using the precast system. The cost of this monolithic lining is

said to have been one-third more than that built by the precast method. The initial cost of the latter method can be kept still lower when the lagging is still in good shape by postponing the addition of the slabs which is a separate operation entirely.



CRANE LOADING RIBS ON FLAT CAR

Note reinforcing rods projecting from upper end of ribs. The ribs weigh about 5 tons each.

In addition to the lower cost, advantages claimed for the precast unit method are that (1) it eliminates form work in the tunnel,, (2) affords the best opportunity for securing good concrete by making it possible to pour in the open air where there is ample time for thorough curing and inspection, (3) a timber lining can be economically replaced without the necessity of working continuously through the tunnel as the precast ribs can be quickly placed at any point where the wood bents have become decayed or faulty and when in place the concrete ribs can carry the load immediately, (4) the dangers due to green concrete and form work in the tunnel are eliminated.

The process was designed and patented by Pierre Zucco of Pierre Zucco & Co., consulting engineers, San Francisco, Calif.

Garbage Furnace Selections by Small Cities

Some of the difficulties met by small cities in selecting a garbage incinerator from the various kinds now available were set forth as follows by Samuel A. Greeley, consulting engineer, Chicago, in a paper recently presented to Michigan Engineering Society:

As regards incineration, the most difficult hurdle is the selection of a furnace. A variety of incinerators are on the market, most of them under active salesmen with very little yard stick for comparison. The only specific advice that can be given of general applicability is that the principal factors contributing to the failure of an incinerator are faulty design in one or two important particulars, and general poor construction both as regards material and workmanship. It is surprising the extent to which the smaller communities are willing to put themselves in the hands of a contractor building an incinerator, whereas in the construction of a sewer, thorough engineering supervision and inspection are provided. In some incinerators insufficient furnace bracing is provided, or the main flue is too small, or the door castings are too light. In others the foundations are too light, or the fire brick work is poor or the general arrangement for receiving refuse is awkward. Many incinerators throughout the country are apparently disposing of refuse with more or less success. One of the major difficulties results from the lack of engineering.

In concluding his paper, Mr. Greeley said:

In no community should the refuse disposal problem be approached without first establishing for that community the fundamental considerations. After these are determined, careful engineering work should be given to the development of the details so that failure will not result.

Higher Stresses for Steel Buildings Proposed by Fabricators

A BASIC working stress of 18,000 lb. per square inch is proposed in a specification for structural steel for buildings recently adopted by the American Institute of Steel Construction, an association of steel fabricating concerns. The specification was prepared for the association by a board of engineers retained for the purpose, consisting of Prof. George F. Swain, Prof. M. S. Ketchum, E. R. Graham, W. J. Watson, and W. J. Thomas. Essential provisions of the specification are summarized in the following:

Material—Bridge steel is specified (A.S.T.M. 1921 specification), thus calling for material of slightly higher ductility than building steel as currently specified, but no higher in ultimate strength or yield point, which are 55,000-65,000 and one-half of the ultimate, respectively.

Impact for Live-Load—In the case of live-loads which tend to produce impact or vibration, an impact addition to the static live-load stress is specified. The amount of this addition is not specified.

Minimum Thickness—For steel in outside exposure, $\frac{5}{16}$ in. is fixed as minimum thickness; for inside exposure, $\frac{1}{4}$ in. Light structures, including one-story buildings, are excepted.

Heavy Trusses—Girders or trusses having end reactions of 40,000 lb. or more are to be supported on steel columns carried to the foundation. The gusset plates in such trusses are to be not less than $\frac{3}{8}$ in. thick.

Workmanship—Punched work is permitted, but workmanship "equal to the best practice in modern structural shops" is required. Faced edges are required only at the contact surfaces of compression joints.

Construction Details—Faced ends of compression members are required to be spliced only sufficiently to hold the connecting members in place.

Rivets of a length exceeding five diameters are to be increased in number 1 per cent for each additional $\frac{1}{16}$ in. of grip, and are to have the points quenched before driving. Members are required to have centric connections and the connection rivets are required to be centric to the members unless the eccentricity is provided for. The fixation moment at the end of a beam connected to another beam rigidly is to be provided for. No shop connection is to have less than two rivets and no field connection less than three.

Web Stiffeners—At the ends of plate girders and rolled beams, web stiffeners are required. Stiffeners are also required where the average web shear exceeds that allowed on an unstiffened web, and in this case the stiffener spacing should not exceed the permissible depth of an unstiffened web under the same unit shear, determined by the formula

$$42.4\,t\sqrt{18{,}000\,A/S - 1}$$

where t is the web thickness, A is the gross web area, and S is the total shear. In any case plate-girder webs are to have a thickness not less than 1/160 the unsupported distance between flanges.

Allowable Unit Stresses—The following are the principal items of the allowed working stresses:

	Lb. per Sq.In.
Tension, bending and short-length compression	18000
Column compression, gross section	$\frac{18000}{1 + l^2/18000r^2}$

with a miximum of 15000 and with l/r limited to 120 for main members and 200 for bracing	20000
Compression in unstayed beam flanges	$\frac{}{1 + 1^2/20000b^2}$
with l/b limited to 40 as a maximum	13500
Shear on pins and power-driven rivets	12000
Shear on turned bolts	10000
Shear on hand rivets and rough bolts	
Bearing values, twice the shear values	
Shear on girder webs, gross section	12000
provided h, the depth between flange angles, does not exceed 30t. For greater depth the average shear on the vertical section must not exceed	18000
	$\frac{}{1 + h^2/18000t^2}$
Bearing on expansion rollers	6000

Increase for Combined Stresses—Stresses may be increased 25 per cent for load and wind in combination, and 33⅓ per cent for wind stresses in members carrying no load stresses.

Reversed Stresses—Members subject to stress reversal are to be designed to carry either stress with half the smaller added.

Water Softening at Columbus, Ohio —Results and Studies

Long Settling Periods Probably Are Unnecessary; Overtreatment of Small Portion Is Desirable

Extracts from paper presented to Indiana Water Supply and Sanitary Associations, Feb. 15, by Charles P. Hoover, chemist in charge, Columbus (Ohio) Water Softening and Purification Works.

DURING the fourteen years that the softening plant at Columbus, Ohio, has been in operation 10.7 lb. of lime per million gallons of water has been required to reduce the hardness 1 p.p.m. and 11.5 lb. of soda ash per million gallons has been required for each part per million of hardness reduced. Of this 2.3 lb. has been neutralized by alum added for coagulation purposes leaving 9.2 lb. as against a theoretical 9.1 lb. actually required. Costs of operating and maintaining the plant since 1909 have varied from $14.58 to $37.32 and averaged $22.91 per million gallons. The cost of chemicals included in these figures varied from $8.90 to $30.78 and averaged $16.38 per million gallons.

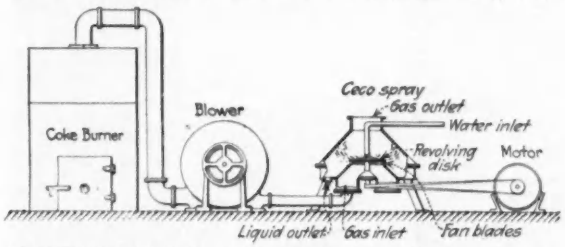
Recent studies have disclosed that temperature is a far greater factor than time in completing the chemical reactions. The effect of temperature is more pronounced in water having a hardness above 400 than in water with less than 300 r.p.m. At higher temperatures ess calcium and magnesium remain in solution than at lower temperatures. At higher temperatures the reaction between the lime and the soda-ash and the calcium and magnesium salts results in a more crystalline and thus less soluble precipitate than at lower temperatures. As the temperature lowers, more and more colloidal and soluble is the precipitate formed.

Results at Columbus from 12,000 determinations during the past eleven years indicate that the period of reaction between the softening chemicals and the calcium and magnesium is short. Ninety per cent of the reaction accomplished takes place in the mixing tanks, 3 per cent in the 15 hours through the settling basins, and 7 per cent in passing through the filters.

The average hardness of the river water is 273 p.p.m.; of the water entering the settling basins, 119 p.p.m.; at the outlet, 113 p.p.m.; and of the filtered water, 101 p.p.m. These figures are rather startling because they indicate that large settling basins are not so necessary for water softening as has always been supposed. The results indicate that the colloidal precipitates crystallize in passing through the settling basins and are thus removed, but that it is not the place where chemical reactions take place. The filters are more effective in removing colloids than the settling basins, and in addition to removing 7 per cent of the hardness, I believe would also have removed the 3 per cent lost in the settling basins.

As temperature is a factor over which no control is possible in a large plant, it is essential to take advantage of such factors as can be controlled. At the Columbus plant and at the new plant at Newark, Ohio, all of the chemicals required to soften the water are added to a portion of the water, approximately 25 per cent, which is subsequently mixed with the 75 per cent undosed portion. This overtreatment gives the effect of mass action, resulting in quick formation of large flocs and crystalline precipitate.

After mixing the undosed portion with the dosed portion, the mixture is made to pass slowly through baffled mixing tanks. The large flocs already formed serve as a nucleus upon which the newly forming precipitates can build, and as the water rolls over and under the baffles, the flocs seem to grow in size, very much the same as rolling up a snow ball. By the time the water reaches the settling basins, it is so well coagulated that sedimentation takes place almost instantaneously. The suspended matter in well softened water should settle in five minutes' time, but I have never been able to duplicate plant results in this respect in bottle experiments.



PLANT FOR MAKING CONCENTRATED SOLUTION OF CO_2

Another factor that tends to improve coagulation is the addition of aluminum sulphate applied to the raw water at the same point that the lime and soda-ash are added. When the Columbus plant was built, provision was made for applying coagulant at the entrance to each or any set of basins, at the outlet of the last set of settling basins, or in the softened water channel on the way to the filters. The process of adding the coagulant to the water in the settling basins was soon changed and better results were obtained by adding most of the coagulant to the raw water as it entered the plant and a small additional dose to the settled water as it passed to the filters.

Carbonation—In experiments on carbonation, made during the past year, in the first plant CO_2 gas, in cylinders, was applied to water by means of a chlorinator. A sketch of the second plant is shown. It consists of a coke burner and a blower for sucking the gases from the burning coke and forcing them into an absorber. The CO_2 gas enters at the bottom and the water is fed in at the top. The water drops onto a disk which revolves at the rate of 1,800 r.p.m. and the gas meeting this film of water is absorbed. The carbonated water, discharged from the absorber, during a few of our tests, contained as high as 600 to 700 p.p.m. This process consists in highly carbonating a portion of the water and feeding the highly carbonated portion into the balance of the supply.

Another carbonator on the market, used by the soft-drink bottling plants, when operated at 30 lb. pressure, produces an effluent showing 24 lb. of CO_2 in 500 gal. Theoretically one of these carbonators would produce enough CO_2 to carbonate 2,000,000 gal. of water. The cost, including a 2-hp. motor, is about $900. Theoretically, 171 lb. of CO_2 gas would be required to carbonate 1,000,000 gal. of Columbus softened water. At the water softening plant at Defiance, however, 450 lb. of CO_2 gas are prepared for each million gallons of water treated and on this basis one carbonator would absorb enough gas for only 1,000,000 gal. of water.

Old Bollman Truss Bridges on the Valley R.R. of Virginia

Three Bridges Now Being Replaced Have Carried Traffic for Fifty Years Without Structural Change

By Philip George Lang, Jr.
Engineer of Bridges, Baltimore & Ohio R.R., Baltimore

PECULIAR historic interest attaches to three old bridges on the Valley R.R. of Virginia (part of the Baltimore & Ohio R.R.), now in process of replacement with modern spans. The section of line in question traverses the Shenandoah Valley between Harrisonburg and Lexington, Va. The bridges involved, which are shown by views herewith, are single-track structures, and may be briefly described as follows:

Bridge 117, crossing the North River west of Mount Crawford, Va., comprises two deck Bollman truss spans of 98 ft. 6 in., and one deck Bollman truss span of 148 ft. 9 in. Bridge 120, crossing the same stream east of Cave station, consists of two deck Bollman truss spans of 98 ft. 7 in. and 63 ft. 5 in. respectively, and one deck Whipple truss span of 147 ft. Bridge 129, crossing Middle River east of Verona, consists of three deck Bollman truss spans, each 98 ft. 7 in. long, and one deck Whipple truss, 147 ft. long. All the spans given are measured center to center of end bearings.

The piers and abutments supporting these structures are built of good quality limestone, derived from the inexhaustible local supply found in the underlying strata of the Shenandoah Valley, upon which also the substructures foot. The existing masonry is in good condition, and, with slight modifications to accommodate the new superstructures, will be continued in use.

Records covering the fabrication and erection of these spans are no longer available, but it is believed that the superstructure of bridge 117, at Mount Crawford, was fabricated in 1872, at the Baltimore & Ohio R.R. Co. bridge shop, then located at Mount Clare, Baltimore. Bridges 120 and 129 built either in 1872 or 1873, were possibly fabricated at the same point, although they may have been built at the plant of the Patapsco Bridge & Iron Works, Canton, Md.

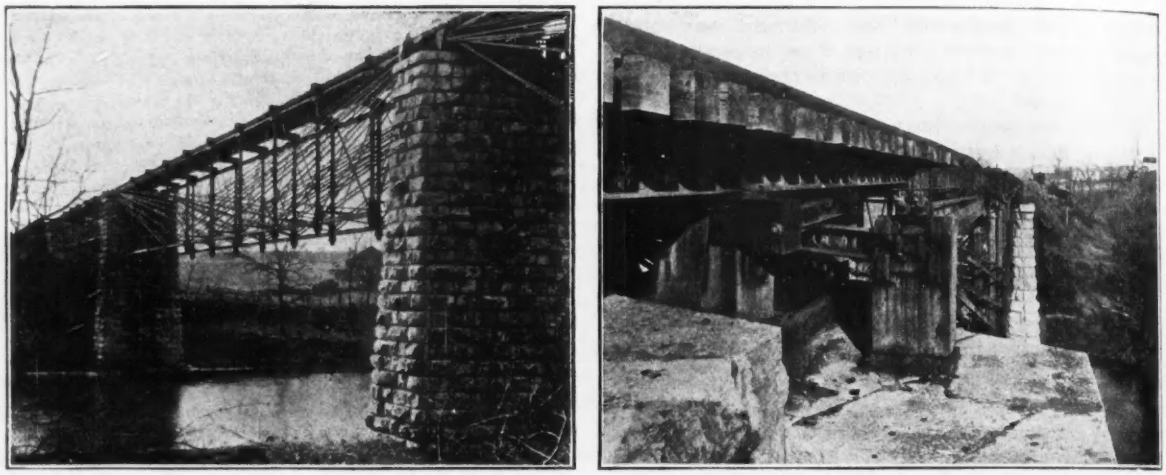


FIG. 1—CHANNEL SPAN (148 FT. 9 IN. C. TO C.) AND END BEARING OF SIDE SPAN (98 FT. 6 IN. C. TO C.) OF NORTH RIVER BRIDGE, MT. CRAWFORD, VA.

The so-called "Bollman" truss was devised and patented by the late Wendell Bollman, a resident of Baltimore, for eighteen years a member of the Baltimore & Ohio organization, and for ten years its Master of Road. Mr. Bollman subsequently became president of the Patapsco Bridge & Iron Works, and in that capacity was engaged for several years in the design and fabrication of iron bridges.

These old spans constitute interesting relics of the past, and embody concrete examples of what was con-

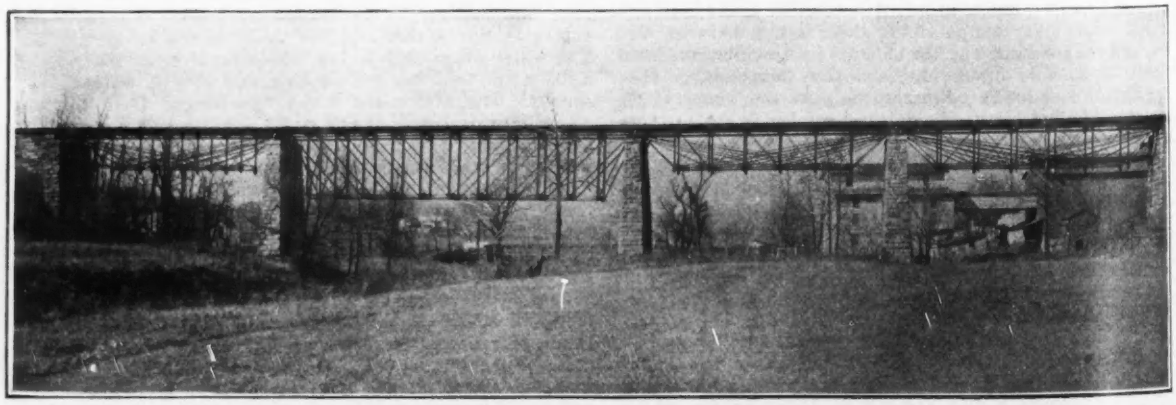


FIG. 2—MIDDLE RIVER BRIDGE AT VERONA, WITH WHIPPLE CHANNEL SPAN AND THREE BOLLMAN SIDE SPANS

sidered first-class bridge practice fifty years ago. The history of the engineering profession would be vastly enriched were equally perfect specimens of contemporary motive power and rolling stock available, to visualize to our own generation the rolling loads contemplated by the bridge designers of half a century ago.

The fact that since the early 70's locomotives and rolling stock have been subject to steady increase in weight and severity of effect on bridges is forcibly illustrated by the structures now considered, which have been continued in operation under the lightest types of current motive power, subject to speed restrictions. However, notwithstanding the age of the spans, and the fact that even the light classes of power operated over them far exceed in effect the loads contemplated by the designers, their replacement is not due to actual deterioration but to the changing character of the traffic now operated on this line.

In the Bollman truss the panel loads are transferred directly to the end bearings, and this action is accompanied by an undulatory action, to which the term

FIG. 3—SPAN OF 63 FT. 5 IN. NEAR CAVE STATION

"weave" has been applied, and which is particularly noticeable in the deck type, represented in the Valley Railroad bridges.

The floor construction of these bridges was never changed or any other alteration made in their structure. Their extended life and utility, and the fact that it has been possible to maintain them for many years under conditions which their designers could not foresee, is a striking proof of the excellence of the material and workmanship used in the completed structures. These examples of railroad bridge super-structures, now rapidly disappearing as current structural types, represent an important link in the development of the present-day metallic railroad bridge, and constitute an enduring monument to the skill of a past generation of railroad builders, who successfully encountered the problems of their day.

Water and Sewage Plants in Minnesota

Of 400 water systems in Minnesota, thirty-eight are surface supplies. Twenty of the latter receive some kind of treatment and five of the remainder are taking steps toward treatment, said J. A. Childs, engineer, Minnesota State Board of Health, at the recent meeting of the Minnesota Surveyors and Engineers Society. Of eighty sewage treatment works seventeen are septic tanks and sixty-three are Imhoff tanks. Only forty-five of the Imhoffs are adequate in size.

Looking for Gravel for Road Construction

Abstract of Paper Presented to Minnesota Surveyors and Engineers Society by C. A. Motl, Assistant Engineer, Minnesota State Highway Department.

INVESTIGATIONS for gravel should be carried on continuously. The engineer should study his particular territory minutely, both in the field and on the maps available, and should take advantage of every indication that might occur. Special vegetation is perhaps the best indicator that we have, where the soil covering is not too deep. Gravel pits should be located if possible in advance of any construction, as their location might often influence the route to be taken. The engineer should bear in mind that gravel will be needed for many years to come, and the securing of an adequate supply in advance is just as important as the building of a permanent bridge or culvert.

In making the investigation, it is well, first, to take preliminary soundings over the area under investigation. These soundings should be made wherever there is an indication of gravel existing. Where gravel is found, a sample should be taken and preliminary screen and quality tests made. Where the indications appear to be most favorable, more extensive soundings should be taken, and more tests made, until the engineer is absolutely certain that he can guarantee a given amount of gravel in the pits he has chosen. A record map should be made of the location of all the preliminary, as well as final soundings and tests, so that the work will not need to be duplicated in the future.

In the past it has often been customary to limit the gravel investigation merely to pointing at a hill and telling the contractor to "go to it." In many cases after the contractor went, he soon came back, with nothing to show for his trouble but a long bill of extras. Since all other items of construction appear to be carefully investigated by surveys and extensive plans, why should not gravel pits be included along with the rest? Correct information on this item is as necessary as the balance of quantities on a grading plan, or the giving of volumes on a concrete bridge.

As a general suggestion, it may be said that a gravel deposit should be surveyed, by surface measurements covering both the location and the contours; by soundings giving depth of strippings and gravel, and by tests, giving quality, quantity, and screen sizes at various depths at all the test holes. Test holes should not be over 50 ft. on centers, and in many deposits much closer. An accurate plat should be made of all the information obtained, and this plat should become a permanent record in the engineer's office. With such information, it will be known in advance, just how much oversize there is in the gravel; how much clay for binder (this is important in sandy soils); how much stripping is required; how the gravel should be taken out to give the best results, and what kind of equipment would be best to use in the pit.

Pineapple Co. to Develop Island of Lanai

The Hawaiian Pineapple Co. has recently purchased practically the entire island of Lanai which is one of the Hawaiian group located about 55 miles from the City of Honolulu, Island of Oahu. Lanai is the sixth largest of the group and comprises about 139 sq. miles. Beginning next year considerable areas on the island are to be planted to pineapples which will be shipped to Honolulu for canning, and in order to facilitate transportation a suitable harbor and modern structures will be provided on the island. The harbor will be developed at Kaumalapu on the southwest side of the island where a small bay is sheltered on three sides by high cliffs. With a small breakwater and some dredging this is to be made into a safe port for steamers of the type expected to handle the pineapples. Francis B. Smith of San Francisco has been retained by the company as consulting engineer in connection with the development of transportation and harbor facilities.

Structure of Collapsed Hartford Water-Tank Tower

Inclined Columns of Tank Supported on Grillages at Fifth Floor Level—Swaybracing Removed Before Collapse

By Prof. Carlton T. Bishop
Sheffield Scientific School, Yale University, New Haven

As reported in last week's issue (p. 640), the collapse of the main entrance tower at the new plant of the Fuller Brush Co. in Hartford, Conn., on March 31 resulted in the death of ten men. The tower projected from the center of the front face of the main three-story-and-basement building, and was 28 ft. square, about 113 ft. high above the ground, and 124 ft. high above the foundation. A 50,000-gal. water tank contained in the top of the tower was supported by four inclined steel columns which transmitted the load

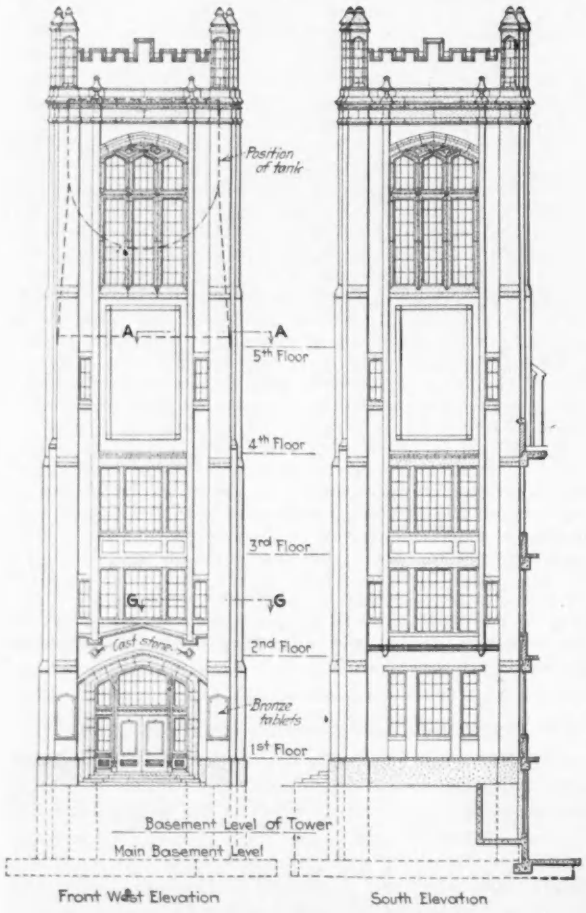


FIG. 1—FULLER BRUSH CO. TOWER
Tank in upper part filled at time of collapse

to the brick walls by means of grillage beams at the fifth floor level, about 65 ft. above ground.

The outward thrust of the inclined steel columns of the tank was resisted by horizontal channels connected by bent plates to the columns about 1½ ft. above their bases. These channels joined adjacent columns, thus forming a square, no provision being made for direct connection between diagonally opposite columns. Just inside the walls and immediately above the fifth floor was a reinforced-concrete coping. The five 1-in. square rods in this coping were bent down at the ends "under and between" the grillage beams, but it is not clear

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FIG. 2—TOWER SHORTLY AFTER COLLAPSE
View looking north; southwest corner of tower gone.

whether or not they were so bent that they would be effective in preventing the spreading of the column footings.

One of the men who was fatally injured said that he had seen a large crack in the front wall of the tower under the large upper window. This would be only one or two feet above the column footing. He reported his discovery to the vice-president of the contracting company and they were on their way to the crack when the crash came which killed them both.

Another development is the fact that at least half of the eight 1-in. square swaybracing rods in the side faces of the steel tank support had been removed the afternoon before the accident. These rods extended from the top of each column to the bottom of the adjacent columns. The rods were removed by order of the engineers, who maintained that they were not necessary after the tank was enclosed by the walls so that no wind pressure on the tank need be considered. The daily press is placing emphasis upon the fact that the tower failed in less than 24 hours after the rods were removed, whereas up to that time it had stood two or three weeks after the tank had been filled. The rods were removed because they interfered somewhat with the use of the space under the tank. After the tower was nearly completed it was decided to use this space as a school room for the instruction of branch man-

agers and assistants. A new floor was placed about 3 ft. above the original fifth floor, to obtain a greater floor area. A ceiling was constructed below the tank, the central and corner portions being horizontal, while

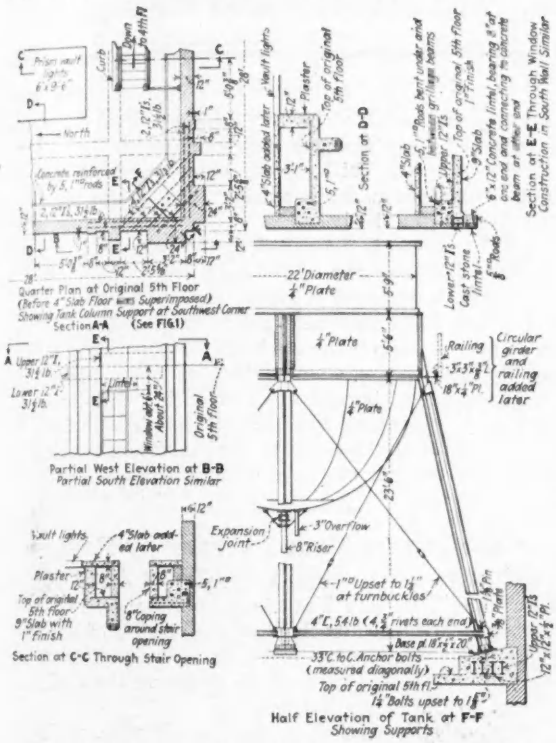

Quarter Plan at Original 5th Floor
Section A-A
Partial West Elevation at B-B
Partial South Elevation Similar
Section at C-C Through Stair Opening
Section at D-D
Section at E-E Through Window
Construction in South Wall Similar
22'Diameter
Half Elevation of Tank at F-F
Showing Supports

FIG. 3—TANK SUPPORT AND DETAILS OF FLOORS AND WALLS

the side portions sloped upward to include all of the lower windows. The exposed portions of the steel columns were wrapped with metal lath and plastered.

The city's supervisor of buildings has announced that his investigation, in which he was aided by A. S. Lynch, consulting engineer of New Haven, shows "that the cause of the disaster is in no way related to the permit for the erection of this plant nor to the plans and specifications filed in the office of the Supervisor of Buildings. I am satisfied that the cause of this disaster was beyond the control of this department." The engineering firm of Greenwood & Noerr of Hartford investigated the collapse for the general contractors who built the main building and all of the tower except the steel tank and supports. These engineers have reported that the R. G. Bent Co., the contractors, built the tower according to the plans and specifications furnished them by the architects, that their work was all that could be asked for, and that the contractors should be absolved from any blame for the collapse. The report of H. G. Balcom, consulting engineer of New York, who investigated for the Fuller Brush Co. and for the architects and engineers, Buck & Sheldon, of Hartford, has been made. This report is said to have fixed the responsibility and it is awaited with much interest, although its findings will not be made public until released by the State's Attorney.

The accompanying drawings have been adapted from the architect's drawings, obtained through the courtesy of Buck & Sheldon. Fig. 1 shows the front and side elevations of the tower with the position of the tank indicated. Fig. 2 is a view of the tower soon after the collapse. The southwest corner was completely destroyed. The upper portion of the north wall, which remained, was such a menace in the high wind that only the firemen and those most intimately interested ventured into the ruins to search for the bodies of those buried. An attempt was made to pull it down by means of cables attached to two trolley work-cars, but two charges of dynamite were required before the wall finally fell. The east wall was subsequently removed by men working on staging.

The tank as well as the masonry fell substantially straight down. A certain amount of the debris spread forward, or to the west, as may be seen from the view, Fig. 2.

Fig. 3 shows the arrangement of the tank and its supports. The four plate-and-angle columns rested on grillage-beam footings at the corners of the tower, and each column was anchored to the footings by two 1¼-in. bolts passing through a plate on the under side of the upper grillage beams. These grillage beams were all embedded in concrete, and a reinforced-concrete coping surmounted the floor at the walls on all four sides. The upper diagonal beams rested upon the lower beams in the walls. The lower beams rested either upon the brick walls or upon the reinforced-concrete and cast stone lintels over the windows. The tops of the windows were about 1 ft. below the lower beams. The concrete lintels were wall-bearing at one end, but connected to the reinforced-concrete floor beams which entered the walls at the opposite sides of the windows. The bearing of these floor beams was increased by additional concrete on the sides away from the wind ws, doubling the width of the beams as they entered the walls.

For the sake of clearness the plan shows the original fifth floor before the additional school-room floor was added. The sectional views indicate the method of sup-

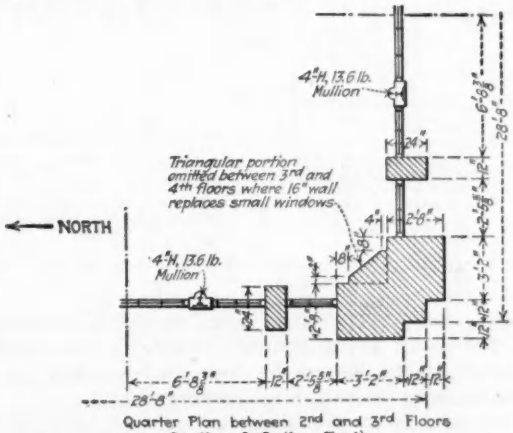

4"H, 13.6 lb. Mullion
Triangular portion omitted between 3rd and 4th floors where 16" wall replaces small windows
NORTH
4"H, 13.6 lb. Mullion
Quarter Plan between 2nd and 3rd Floors
Section G-G (See Fig. 1)

FIG. 4—WALL DETAILS IN SECOND STORY

porting this additional floor. The stairs shown in the plan were extended to reach the upper floor.

The 12-in. walls with pilasters extended from the column footings down to the fourth floor, where the pilasters were increased in thickness. Between the fourth and third floors the central wall panels were replaced by windows, and between the third and second floors small windows were added, so that the remaining wall areas were as shown in Fig. 4. There were two steel mullions in each side of the tower as indicated.

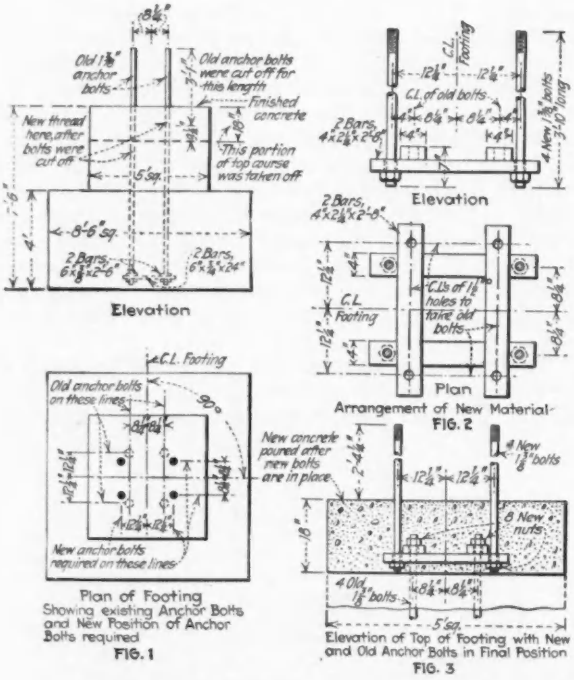
From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Placing New Column Foundation Anchor Bolts While Using Existing Ones

By Harry J. Finebaum
Resident Engineer for Clarence W. Hudson, Hill-to-Hill Bridge, Bethlehem, Pa.

IN ONE of the column foundations which had been built for the viaduct portion of the Hill-to-Hill Bridge at Bethlehem, Pa., it was found necessary to revise the position of the anchor bolts so that the axes of the bolts in the new position would be 90 deg. with those of the existing bolts. The latter were embedded practically the full depth of the concrete footing and were held together at the bottom by four anchor plates in accordance with the design as shown in Fig. 1.


Old 1¾" anchor bolts
Old anchor bolts were cut off for this length
Finished concrete
New thread here, after bolts were cut off
This portion of top course was taken off
6' Sq.
8'-6" Sq.
2 Bars, 6"x¾"x2'-6"
2 Bars, 6"x¾"x24"
Elevation
C.L. Footing
Old anchor bolts on these lines
New anchor bolts required on these lines
Plan of Footing
Showing existing Anchor Bolts and New Position of Anchor Bolts required
FIG. 1
2 Bars, 4"x2¼"x2'-6"
C.L. of old bolts
4 New 1⅜" bolts 3'-0" long
Elevation
C.L's of 1⅜" holes to take old bolts
Plan
Arrangement of New Material
FIG. 2
New concrete poured after new bolts are in place
4 New 1⅜" bolts
8 New nuts
4 Old 1¾" bolts
5' Sq.
Elevation of Top of Footing with New and Old Anchor Bolts in Final Position
FIG. 3

METHOD OF PLACING NEW ANCHOR BOLTS

The method of providing new anchor bolts, herein described, was devised under the desideratum that the new anchorage must be as positive as the one designed originally, in its ability to resist uplift. Fig. 1 shows the plan and elevation of the existing foundation and its anchor bolts.

Eighteen inches of the top course of the footing were taken off by means of air drills and feather wedging and the exposed surface levelled by hand chiseling. The four existing bolts were then cut off about 9 in. above this surface and the ends rethreaded. Four new 1⅜-in. bolts with four steel bars, 4 in. x 2¼ in. x 2 ft. 8 in. long, assembled as shown in Fig. 2, were then slipped over the old bolts. The size of these steel bars was determined from the following conditions:

1—Two of the bolts on any one side of the footing were considered under a tension equal to the safe tensile strength of the bolts.

2—The moments developed in the bars by the above assumed forces acting on the bolts were then computed and the bars designed to carry these moments.

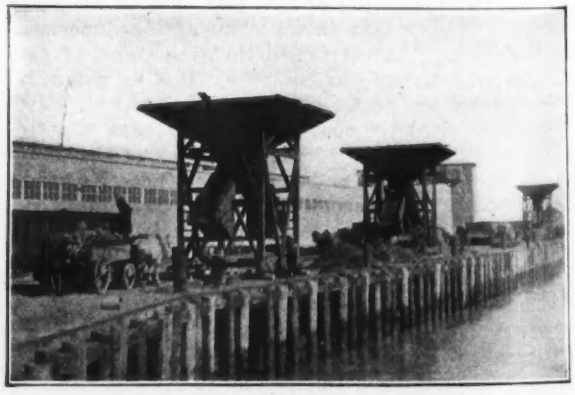
The new bolts were next set to the correct elevation, nuts were placed on the old bolts and turned to a bearing on the upper surface of the top 2¼-in. bars. The final assembly of the old and new anchor bolts is shown in Fig. 3. Concrete was then poured to complete the top course of the footing to the finished elevation required for seating the steel column.

Coal Towers Made Portable by Rollers

BECAUSE of the large shipments of coal and coke coming into San Francisco by steamer, the State Harbor Board has just finished the placing of six large rollers under each coal tower, so that the towers can be easily and quickly moved to points on the dock convenient to the ship's hatches.

Previously it required a crew of six men, with two hydraulic jacks and rollers and a motor truck, to move one of the towers. With this equipment it required about two hours to move a tower only a few feet on the dock. Now, by means of the rollers placed under the towers, any tower may be moved in five minutes by the ship's tackle.

Each of the rollers is 8 in. in diameter and 3 ft. 6 in. long, with a 10-in. groove in the center. There is an iron bark bearing for each roller which is connected



WOODEN ROLLERS FACILITATE MOVING OF TOWERS

to another iron bark timber which in turn is bolted to the timbers supporting the tower. A large greased iron washer is placed between the two iron bark timbers, enabling the rollers to be turned at any angle, thus permitting the towers to be moved in any direction along the dock.

Liquid Oxygen for Blasting Operations

RECENT SUCCESSFUL use of liquid oxygen for blasting in mining operations at Pachuca, Mexico, suggests its practicability and economy for certain kinds of excavating operation in engineering construction. In a notable paper presented last month at the New York meeting of the American Institute of Mining and Metallurgical Engineers, M. H. Curlya and G. H. Clevenger give full details of the operations at Pachuca. Under the conditions the authors find an excellent case for liquid oxygen as compared with the ordinary explosives used in mining.

The production of liquid oxygen explosive is a field operation. It involves the installation of a liquefying plant and the provision of containers and minor apparatus for making the cartridges. At Pachuca the liquefying plant had a capacity of 25 liters per hour and the cost was 2.79c. per pound. With a larger and improved plant it is estimated that the cost could be reduced to 1.86c. per pound. These are operating costs exclusive of capital charges and overhead.

From the plant the oxygen is carried in special flasks to the working face. Here it is poured into other special containers into which the cartridges are dipped and soaked. The absorption process requires about 10 minutes and during this time and in pouring the liquid there is large loss by evaporation. The cartridges are paper cylinders filled with an absorbent—carbon black was used at Pachuca. Once dipped the cartridges have to be used quickly as they become non-explosive in about half an hour. They should be prepared for firing, put in the holes and fired at a certain age in minutes, which differs with different absorbents and wrappers, when their explosive effect is maximum. The explosion is by detonation using ordinary electric detonators. The cost as given in the paper referred to is as follows:

The cost given herewith is computed and stated on the basis of the comparative cost of 40 per cent gelatin dynamite. These unit costs have been derived from the present operations. Liquid oxygen 2.79c. per pound, carbon-black cartridges 1.38 x 12 in. 1.85c. each, and 1.1 x 12 in. 1.40c. each. The equivalent of 1 lb. 40 per cent gelatin dynamite requires 2.1 lb. of liquid oxygen and 1.8 cartridges 1.38 x 12 in. and 2.6 cartridges 1.10 x 12 in. The total cost then of L.O.X. equivalent in breaking effect to 1.0 lb. of 40 per cent gelatin dynamite would be:

	Cents U. S. Cr.
2.1 lb. liquid oxygen at 2.79c. per lb.	5.86
1.8 cartridges at 1.85c.	3.33
Total cost, if 1.38 by 12 in. cartridges are used...	9.19
2.1 lb. liquid oxygen at 2.79c. per lb.	5.86
2.6 cartridges at 1.40c.	3.64
Total cost, if 1.10 by 12 in. cartridges are used...	9.50

Average total direct or operating cost of, say, 9.35c. per lb. No allowance is made in this for amortization or interest on the capital expenditure for the liquid-oxygen plant and equipment. In other words, 40 per cent gelatin dynamite would have to be delivered at the mine for 9.35c. U. S. Cy. per lb. (20.6c. U. S. Cy. per kg.) to equal the direct costs secured with L.O.X. in an experimental unit.

WITH the active season in construction work near, increased opportunity will be offered contributors to enliven the pages of ***"From Job and Office"*** with new ***"how to do it"*** articles. There is a tendency to let pass, in the stress of actual planning and execution of engineering-construction projects, details that are worth talking about. Help us make this specialized "kink" section of *Engineering News-Record* a story of the season's progress. Any person, either in the office or out on the job, is a potential contributor.

Summarizing the case for and against liquid oxygen explosive the paper states:

The advantages of L.O.X., which are somewhat the same as those given by various authorities, but with added weight on account of demonstration at Pachuca, are briefly as follows: (1) A substantial saving in cost over the present cost of dynamite. (2) Greater safety, although it is difficult to place a definite monetary value upon this advantage. (3) Freedom from noxious gases, when properly used, renders it possible to return to the working face sooner than when dynamite is used. (4) Small increase in the oxygen content of the air at the working face is an advantage. (5) Although the powder magazine cannot be entirely dispensed with, there is no hazard from the storage of large quantities of high explosives. (6) Entirely eliminates thawing of powder; this is of no consequence at Pachuca but in a cold climate it would be an important advantage. (7) No high explosive in the waste pile or mill bins, for the L.O.X. cartridges become harmless soon after dipping. (8) No danger from drilling into missed holes, for the cartridges are harmless if not detonated soon after loading. (9) No loss of explosive and hazard to innocent persons through theft of explosive. (10) A feasible and economical method whereby mining companies can manufacture their own explosive. (11) The liquid oxygen can advantageously be used for welding and cutting, also in mine-rescue apparatus.

The disadvantages of L.O.X. are likewise much the same as those that have been previously cited by other authorities. These are: (1) Require additional capital expenditure for liquid-oxygen plant and other equipment. (2) The limitation on the number of holes that can be fired in a single round is a disadvantage in large stopes and drifts. (3) Rapid and uninterrupted loading is imperative. (4) Variations in strength and general characteristics of explosive, owing to constantly diminishing oxygen content. (5) Not as convenient to use, especially in inaccessible parts of a mine. (6) With present technique not feasible to use it in holes having running water. (7) Questionable as to the advantage of using it for shaft sinking. (8) Cannot be used in gaseous or dusty coal mines.

The disadvantages cited are not serious and are more than offset by the advantages.

Small-Diameter Dynamite Cartridges Inferior

Extract from report of the Bureau of Mines

BY S. P. HOWELL AND J. E. CRAWSHAW

AS THERE is a continuing tendency to use small diameter drill holes in order to lower drilling costs, and as the small hole requires a small diameter of explosive cartridge, the Bureau of Mines, in co-operation with the Institute of Makers of Explosives, has carried out a series of tests to show the effect of cartridge diameter on the strength and sensitiveness of certain high explosives. These tests show:

(1) That both the rate of detonation and sensitiveness to explosion by influence increase with the increase in diameter of the cartridge.

(2) That gelatin dynamites rapidly decrease in sen-

sitiveness to detonation and explosion by influence on ageing while the ammonia dynamite is little affected.

(3) That the insensitiveness of gelatin dynamites to detonation and explosion by influence on ageing proceeds more rapidly the smaller the diameter of the cartridge.

(4) That the insensitiveness to detonation and explosion by influence proceeds more rapidly with 60 per cent strength than with 40 per cent strength, L. F. gelatin dynamite.

As regards safety, the effect of cartridge diameter is very important, as the more rapid decrease in sensitiveness to detonation of the smaller diameter is likely to cause more misfires, while the decrease in sensitiveness to explosion by influence is likely to cause more partial failures from foreign material in the borehole. Further, insensitive gelatin dynamite sometimes burns in the borehole instead of detonating, and on burning, gives off large quantities of oxides of nitrogen which are very poisonous, even in small percentages. Also, in the smaller diameters of cartridge the proportion of paper wrapper to explosive ingredient is greater, and as most explosives on detonation give greater or less quantities of noxious gases (chiefly carbon monoxide) the smaller diameters of cartridge will give the greater quantities of poisonous gases because of this increased ratio of paper wrapper.

The results obtained from investigation of the samples which failed to detonate show the great importance of well tamping gelatin dynamite shots as this confinement will insure better and more complete detonation.

Accordingly, as the result of these tests which have shown a marked increase in rate of detonation and sensitiveness to explosion by influence for the larger diameters of cartridges and the very marked decrease in rate of detonation and sensitiveness to explosion by influence on ageing of the ¼-in. diameter of cartridge, particularly of the gelatin dynamites, it is pointed out that both economy and safety in the use of explosives are lost by the use of that diameter of cartridges, and therefore, every effort should be made to use drill holes of such a diameter as will accommodate cartridges of not less than ½-in. diameter.

Temporary Wood Truss Spans Gap in Steel Bridge

By L. R. Walker
Inspector, Arizona Highway Department, Palo Verde, Arizona

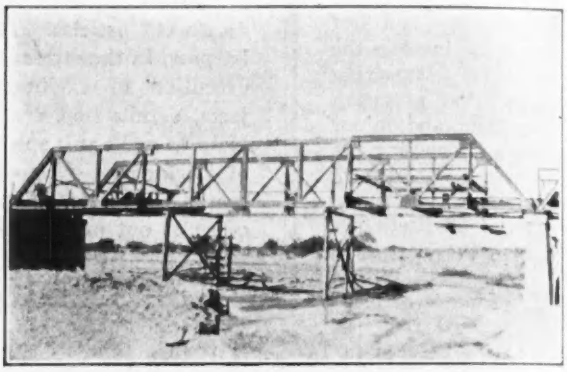
During the construction of a steel bridge carrying the Phoenix-Yuma Highway across the Hassayampa River, 45 miles west of Phoenix, Arizona, a novel use was made of a wooden truss.

The bridge consisted of two 90-ft. pony truss spans connecting 150 ft. of old pile-bent bridge with the opposite shore; the steel spans being supported on two concrete piers in the river bed and a reinforced-concrete abutment at the shore end. Each truss was composed of three sections weighing approximately 6,000 lb. each, and the floor cross-beams were 20-in. I-beams carrying an 18-ft. roadway. One span had been erected and on the other span construction had progressed to the point where a pier section had been placed in position, being supported at the outer end by cribbing consisting of 4 x 6 material, and tied together by three cross-beams; the balance of the sections being in the river bed ready to be raised in position.

From Job and Office

Hints that Cut Cost and Time

Ordinarily, the Hassayampa carries no water except a small amount of canal waste water; but like other dry rivers of the arid regions is subject to floods, generally of short duration, after a heavy rain. On Sept. 2, 1922, such a flood occurred, carrying a large amount of debris. This debris piled up against the old wooden bridge, thus tending to concentrate the current between the piers and creating a very high velocity at this point. The cribbing was soon carried out, dropping the pier sections into the river with the rest of the steel, all of



WOOD TRUSS CONNECTS STEEL SECTIONS

which had now disappeared beneath the surface of the water.

When the flood subsided, all the steel, with the exception of a center section, was found buried in the river bed about 75 ft. downstream from the bridge site. As the lost section was 36 ft. long on the top chord, 18 ft. long on the bottom chord, and 10 ft. deep, no trouble was anticipated in finding it, but after a fruitless search embodying considerable expense and loss of time, it was decided to order a new section and proceed with the erection of the span.

Construction was again started on the span and it was shortly in place and bolted together ready for the middle section to be placed. To prevent the collapse of the span, in the event another flood carried out the falsework, a wood truss was made to fill in the gap pending the arrival of the new section. Riveting was then done over the rest of the span.

The wood truss was made from material the contractor had on hand at the job; the top chord being made of two pieces of 8 x 10-in. stuff spliced together, while the bottom chord was a piece of 10 x 12. They were tied together with three ¾-in. diameter rods; diagonals and posts were of 4 x 6-in. material. The ends of top and bottom chord were cut to fit inside the gusset plates and angles of the steel sections and were securely bolted to them, while the two end rods of the wood truss passed through the bottom plate of each section, thus drawing the wood truss tight against the steel.

While I do not know if this use of a wood truss is new, I have never seen or heard of one being used in this manner before. The wood truss was the suggestion of Merrill Butler, bridge engineer of the Arizona Highway Department. The contractor was A. W. Daniel, and the writer was state inspector on the work.

From Job and Office

For Contractor and Engineer

Materials for Dam Transported by Burros

By L. H. Dieterich
Construction Engineer, Arbuckle Dam, Lyons, Colo.

CONSTRUCTION of a concrete dam under extreme difficulty is under progress at an elevation of 11,300 ft. above sea level in Boulder County, near Longmont, Colorado. The dam is known as Arbuckle Dam No. 2 and when completed will form Arbuckle Reservoir No. 2. The stored water will be used to irrigate the sugar beet fields in St. Vrain valley near Longmont.

The dam is located above the timber line; consequently the construction season is very short, lasting usually from about July 14 to Sept. 10. Outside of this short season the snow and freezing weather make the mountain trails too dangerous to continue construction.

Cement is packed by mules for a distance of six miles up the mountain trails, each animal carrying two bags at a time. Gasoline, tools, lumber and steel reinforcement are supplied in the same manner. Crushed stone and sand are provided at the site, since these materials are of course available in any quantity desired. Power for crushing aggregate is supplied by a 25-hp. gasoline engine.

The laborious nature of this work is well illustrated by the fact that only about 2,000 sacks of cement are used each season, with other materials in proportion. Inasmuch as every two sacks require a round trip distance of 12 miles for one mule, it is apparent that if all the cement for one season were carried by one animal he would have to travel a distance of 12,000 miles.

The dam itself is 203 ft. long and 57 ft. high above the outlet tube. It is a gravity dam of the arch type. The concrete is a 1:2:3 mixture, with fair sized "plums" embedded in the concrete. One-inch twisted steel reinforcing bars are placed near the upstream and downstream faces of the dam, spaced one foot horizontally and vertically. Work was started in 1920 and has progressed each year as much as the difficult location and the short working season permitted. It is expected that the work will be finished in 1923, after 400 cu.yd. of additional concrete are placed.

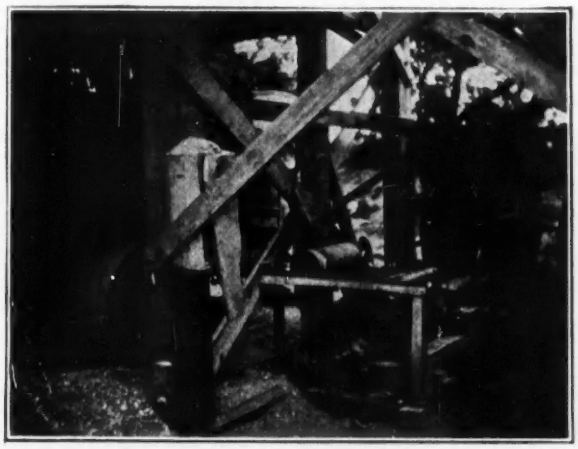
The Arbuckle irrigation project is a locally owned enterprise. The writer, of Lyons, Colo., is the engineer in charge of construction.

MULES BEING PACKED FOR 6-MILE TRIP
Note the gasoline tanks in the foreground. Cement, gasoline, lumber and steel reinforcing bars were carried over mountain trails in this fashion.

Gravel Screening Plant Operated by Truck Motor

By Paul L. Fetherston
Michigan Highway Department, Jackson, Mich.

THIS unique gravel screening plant is being operated by a highway contractor in Michigan with success. The gravel used in surfacing a trunk-line highway in that state must be of such size that it will all pass a screen having 1-in. openings and be largely retained on a ¼-in. screen.



TRUCK MOTOR FURNISHES SCREENING PLANT POWER

Gravel pits are numerous but pit-run gravel will seldom meet with these specifications and as a result it must be screened and the undesirable constituents eliminated before it can be used as surfacing material.

It has been found that gravel containing stone larger than 1 in. in diameter will not wear evenly and will soon develop pits known as "chatter bumps" in the surface of the road, and also gravel containing too much sand and fine material will be easily rutted.

The screening plant shown here was designed by the contractor and it gave such good results that it has served as a model for other contractors in the district.

This plant is operated by a motor truck which is interchangeable with those used on the contractor's fleet of 5-ton trucks. A belt carries the power from the motor to the line shaft from which it is distributed to the elevator and screens. The elevator is made up of steel buckets mounted on a chain while the screens are of the ordinary belt-driven vibrating type.

The plant will handle 1,000 cu.yd. of raw material per day and is operated by two men aside from the foreman who has charge of the work. One man dumps the scrapers at the sump, while the other operates the gate valve which loads the trucks, keeps a record of the material when it is hauled out, and makes tests of the material to make sure that it will pass inspection.

The plant is put together in such a way that it can be dismantled in two days by a gang of eight men, and moved to a new location on five motor trucks.

Footbridge With Bascule Draw

By P. J. Searles
Lieutenant, C. E. C., U. S. N., Indian Head, Md.

A RATHER unusual bridge for pedestrians only was built last year across Mattawoman Creek at the Naval Proving Grounds, Indian Head, Md. It is one of the few foot bridges with a bascule draw. The bridge, erected by the Kitler Elliott Co., has a length of 1,699.5 ft. between abutments and a width of 4 ft.

BASCULE DRAW-BRIDGE FOR PEDESTRIANS

9 in. between handrails. The channel span is 106.5 ft. c. to c. of piers, the piers being 93 and 1,500 ft. from the abutments on the two sides of the creek.

Pile bents are 15 ft. on centers, with 4-in. x 12-in. x 6-ft. caps across the two piers. The piers are cut so as to have 6-in. solid centers to which the caps are bolted with ⅞-in. galvanized bolts. Each bent is cross-braced with two 2-in. x 8-in. planks with the bottom of the braces 7 ft. below the top of the caps. The bents are braced against each other by 2-in. x 10-in. timbers, with the top 1 ft. and the bottom 7½ ft. below the top of the caps. The piles are creosoted.

The floorbeams, four in number, are 2-in. x 10-in. planks bridged 7½ ft. c. to c. and carrying a floor of 2-in. x 6-in. planks laid ½ in. apart. For the channel span steel instead of wood beams were used. The inside floorbeams are lapped 1 ft. and spiked, and the outside beams have a 2-in. x 8-in. splice 22 in. long. The channel span floor is 2 in. x 10 in. bolted to the angles, forming lower cross-bracing between the two trusses. Shore abutments and center piers are of concrete, resting on piles.

The pile driving could not be started because of the shallow water until a channel 40 ft. wide and 6 ft. deep was dredged so as to allow a piledriver to float. The piles ranged from 30 to 35 ft. in length for the abutments and about 50 ft. for the channel piers. Seven-pile dolphins were driven on each side of each pier for protecting the piers from ice and driftwood.

The draw, which is of the Strauss trunnion bascule type, was erected in the open position—76 deg. from the horizontal, or closed position. The concrete counterweight has a total weight of 170,000 lb. It has two pockets for adjusting weights. The draw is operated by a 220-volt 7.5-hp. a.c. motor with a torque of 80 lb. and a nominal running torque of 48.7 lb. A solenoid brake is provided to hold 80 lb. torque. The draw can be opened in 1½ minutes by motor and 3 minutes by two men operating a hand crank.

From Job and Office

Hints that Cut Cost and Time

Scaffold Holds Long Reinforcing Bars

By G. W. McAlpin
Point Pleasant, W. Va.

WHEN concrete abutments were built for two bridges for the State Road Commission of West Virginia during the past season, some difficulty was experienced in placing reinforcing bars in proper position and holding them there while concreting operations went on. Due to the necessity of placing the bars before any concrete was poured for the footings, and due to the extreme length and limberness of the bars the contractor was forced to resort to use of scaffolding.

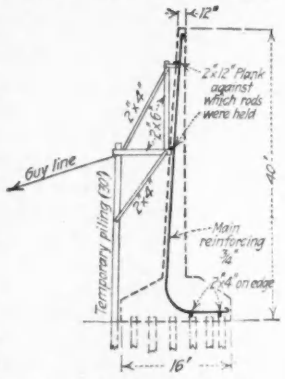


FIG. 1—REINFORCING SCAFFOLD DETAILS

This was accomplished by driving two temporary piles directly in the rear of the main abutment, and from these suspending the scaffold for the main walls and wings against which the rods could be supported. The horizontal part of the bars in the main wall rested upon 2x4-in. pieces securely spiked to the tops of the piling, while the vertical portion of the main bars

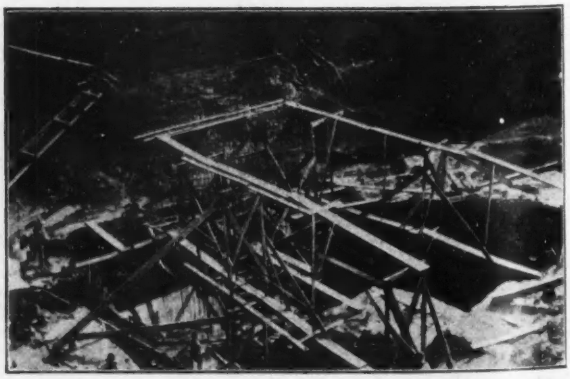


FIG. 2—SCAFFOLDING HOLDING BENT BARS IN PLACE

From Job and Office

For Contractor and Engineer

rested against 12x12-in. planks supported on the scaffold about ⅛ and ⅜ of the distance up from the footing.

By laying off the location of the bars on the 2x4 and 2x12-in. timbers and placing a nail at each point, exact alignment was assured. As each bar was put in place, it was set against the nail and the latter was then bent, holding the bar in place. The entire contract called for 82,760 lb. of reinforcement, with but 1,230 cu.yd. of concrete.

The work was done by Skene & Co., of Huntington, W. Va. H. J. Spelman is the division engineer for the State Road Commission.

Heavy Load Transported More Safely When Suspended From Truss

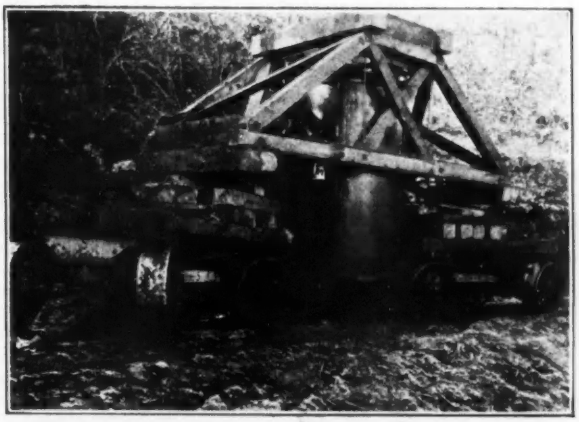
IN BUILDING a series of hydro-electric plants on Pit River in California the Pacific Gas & Electric Co. was obliged to haul three transformers from their Bartle-Pit No. 1 R.R. across country to the Hat Creek power plants. The distance is about 14 miles over a mountain road with 14 per cent grades and many sharp curves. The transformers had to be delivered with the core in the tanks, which meant that they must be kept in an upright position. The transformers are 12 ft. high and shipping weight was slightly more than 13 tons.

The first transformer was loaded on a trailer and hauled in by caterpillar tractors. The gage of the trailer was 5½ ft. and its height 4 ft. 9 in. Hence the top of the tank as loaded was more than 18 ft. above ground and the center of gravity of the load was about 6 ft. above the trailer bed. Delivery was made safely but it required such painstaking effort and involved so much risk, time and expense, that it was determined to bring in the other two with some rig that would keep the center of gravity lower and make for easier handling.

Two trailers were therefore used in connection with a timber truss, as shown in the accompanying illustrations, which made it possible to suspend the load from above. This proved to be a most satisfactory arrangement and was used for moving two transformers without accident.

The truss was built of Oregon pine; contained 1,900 ft. b.m. and 865 lb. of bolts and plates. The total labor cost in putting it together was about $300. The two 12x12-in. transverse members of the truss, each carried two 1¼-in. rods with the lower ends shaped into eyebolts and located so as to conform to the spacing of the four suspension rods of the transformer. Clevises were used to fasten the eyebolts of the truss to the eyes in the tops of the transformer suspension rods. The "draw-bar pull" did not go through the truss but was carried from forward to rear trailer by a tie rod running underneath the load.

An important feature of the rig was that the bolsters

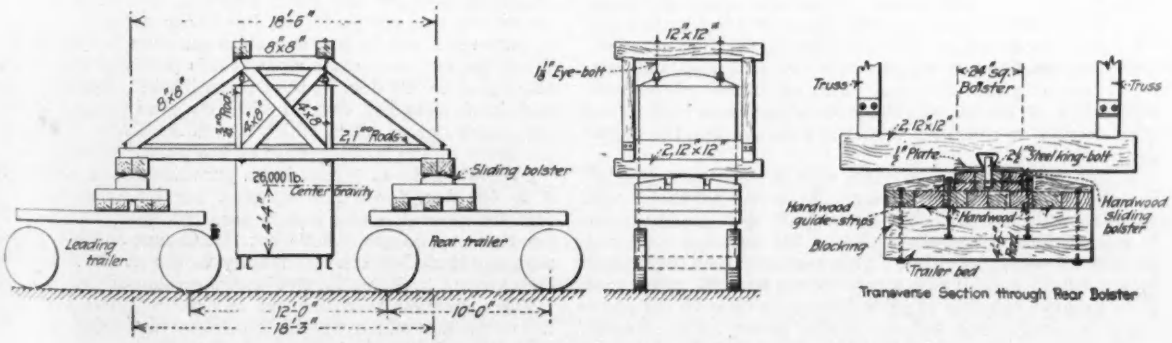


13-TON TRANSFORMER LOADED TO REMAIN UPRIGHT

With this rig two transformers were hauled 14 miles over a mountain road containing many sharp curves and grades up to 14 per cent. Transformers were moved without accident.

on which the truss ends rested (see elevation) were curved so that unevenness of road surface would not rock the load. Hence the transformer remained upright or nearly so even when the road sloped sharply to one side. The upper king pin sockets were made as inverted cones to allow for tilting of the pins. The forward bolster was fixed and the rear bolster was built so it could slide forward and back enough to compensate (1) for the effect of the spring on the rear trailer draw-bar and (2) for the shortened distance between trailers in rounding curves.

The arrangement for loading these transformers was devised by James Martin, construction superintendent. O. W. Peterson is construction engineer in charge of the work.



TRUSS AND TRAILER ARRANGEMENT FOR CARRYING TRANSFORMER

This rig gives the lowest possible center of gravity, keeps the load upright by rounded bolsters and allows for play between front and rear trailers without carrying any pull in the truss.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Los Angeles Not a Minor Port

Sir—An editorial appearing in *Engineering News-Record*, Dec. 21, 1922, p. 1054, refers to the port of Los Angeles as a minor port. A few facts regarding the Los Angeles harbor may be of interest and may serve to correct a wrong impression regarding the importance of the harbor and the amount of business handled by this port.

At the beginning of 1920, the total water commerce through the port averaged about 250,000 tons a month. In January, 1923, the commerce was approximately 1,400,000 tons per month. It is not believed that any other port on the Pacific coast has ever handled a total commerce of 1,000,000 tons in any one month. Fifty-one regular steamship lines carrying general cargoes now serve the port and these lines do not include tank steamer lines nor lumber carriers.

On March 14, seventeen tank steamers were in port to load oil and the total number of vessels in port that day were sixty. While the recent very large increase in tonnage handled is in part due to the tremendous oil development in the region tributary to Los Angeles, the general commerce of the port has been increasing at a very rapid rate.

RALPH J. REED,
Chief Engineer, Union Oil Co., of California.

Los Angeles, Calif., March 19, 1923.

The Tacoma Skew Arch

Sir—The failure of the skew arch in Tacoma (*Engineering News-Record*, Feb. 22, 1923, p. 355) should provoke more than passing interest from the engineering profession. At the time this bridge was designed, about 1911, there was little published about the effect of the skew on the stresses and in fact literature on the subject is very meager at the present time.

By means of models it has been repeatedly shown that the thrust is greater at the obtuse corner (in plan) than at the acute. It naturally follows that the thrust may even reverse and become negative. In the case of the Tacoma bridge the failure clearly indicated this reversal. An examination of the structure showed it much clearer than the drawing accompanying the report. By cutting a piece of stiff paper in a diamond shape and fastening two opposite edges to the table so that it arches between, a model illustrative of the action can be obtained.

If, instead of taking the elevation view perpendicular to the spandrel wall, it is taken parallel to the lower roadway, the arch ring will appear in its true shape and span. With this view all loads (except from spandrel walls) will have no component in the direction of the line of sight. However, the force at the crown in the arch ring will have a component in this direction. This component varies with the design of bridge, angle of skew and load, but is not great enough to cause the thrust to pass through the center of the abutment.

It is a common fault in skew arch design to assume all forces, both internal and external, as acting parallel to the spandrel wall, i.e., to design the arch rib as it would appear in a view looking perpendicular to the spandrel wall and neglect all effect of skew. This neglects very important external loads as well as internal forces, with the result that skew arches are liable to show tension failures in the acute angle or compression failures in the obtuse. The external loads can be approximated or computed but the internal forces require the development of the elastic theory of the arch when skewed or the ability to foresee the results of such an analysis in a general way.

An examination of the Tacoma arch after the failure occurred, showed the effect of tension in this portion of the arch ring, together with earth thrust on the spandrel wall pulling the broken rib from its neighbor. As the steel runs parallel to the spandrel wall, there was little provision to resist this tension. Owing to the solidity of the fill over the arch, the three ribs doubtless acted as a unit to some degree, otherwise tension failure would not have occurred across an entire rib.

Waddell in "De Pontibus" says "A skew bridge is a structure the building of which should always be avoided when it is practicable." After a great deal of study on the theory of the skew arch, the writer has come to the conclusion that Waddell was right, even if the remark was written before the days of reinforced concrete. However, this crossing presents a problem that would be hard to solve in any other way and doubtless this same condition arises at other times. All examples that can be obtained on this important problem should be made available to the engineering profession through its publications that designers may have data from which they can approximate the effect of the skew.

J. CHARLES RATHBUN.

Seattle, Wash., March 21, 1923.

Riveting Painted Surfaces: Some Paint Knowledge Needed

Sir—The tests of riveting painted plates described in your March 8 number, p. 460, are open to the following criticisms:

Laboratory tests (these were such) should be made or supervised by a trained laboratory man—and paint tests especially by some one experienced in paint manufacture.

Mr. Greene says the paint was composed of 67 lb. of red lead to a gallon of boiled oil, plus a gallon of raw oil, plus ⅓ gallon drier. It has long been customary to describe red lead paints as containing so many pounds of red lead (meaning dry red lead) to a gallon of oil; but I think in this case it means 67 lb. paste red lead, which would contain about 62.6 lb. of dry red lead, and a little more than 0.56 gal. of oil. This would make the paint batch contain about 2⅓ gal of oil, and a third of a gallon of drier, and measure almost exactly 3⅔ gal. This means that it contained about 21.7 lb. dry red lead to the gallon of vehicle or 24.4 lb. to each gallon of oil; a rather thin paint.

The important and significant thing is the great amount of drier. Such a paint ought not to have any drier, because the boiled oil contains enough for itself and the raw oil; and if it were all raw oil, five per cent of drier would be enough. Most painters know that a large excess of drier makes paint set up immediately and harden quickly; but what they do not know is that this sudden setting up is a sort of gelatinization, and this apparently dry paint holds the turpentine (which constitutes nearly all of the bulk of the drier) and lets it evaporate very slowly. Exposed to the air, it will in time disappear. The paint may not be as durable as it should be, but eventually the film will come to a stable condition.

But in this case, as soon as one coat was dry, another and another was put on, and, while the final three coats appeared to be dry and hard, probably half of the original turpentine was still in it; solidified turpentine is an article of commerce and is sold for china-painters as "fatty oil." When the hot rivet came close to this paint, if the temperature rose to 320 deg. F. the turpentine in it became a gas and, in blowing out, carried with it a good part of the not very hard linseed oil in which it was dissolved. That was the cause of the "boiling out" of the paint.

I repeat that you cannot harm pure linseed oil by heating it to 600 deg. for a few minutes, nor by heating to 550 deg. for several hours, and it does not boil at these temperatures. I do not doubt what Mr. Greene and Mr. Fickes say; nor that they tried faithfully to get at the facts; but they are not to blame for not knowing some of these things.

The important point is that in this experiment part of the turpentine which was in the drier remained in the film as a kind of solidified gas; and when heated, it became a true gas and forced its way out. It can easily be understood that even a little would make a great disturbance.

New York, March 22, 1923. A. H. SABIN.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

Ceremonies in Connection with the breaking of ground for the construction of the Brooklyn shaft of the Brooklyn-Richmond freight and passenger tunnel will be held at Bay Ridge at 3 P. M. Saturday April 14.

New Cars and Locomotives, costing more than $17,000,000, which have just been ordered by the Southern Railway System, will nearly all be built at points on the Southern's lines. Fifty freight locomotives, 16 passenger locomotives, 5 dining cars, 3,070 box cars, 2,865 hopper-bottom coal cars, 2,000 gondola coal cars, and 200 stock cars are included in the order. All of them are contracted for delivery during the summer.

Investigation of Excessive Overhead charges upon reclamation projects under government control in the western states, according to an announcement of the Department of the Interior, is to be made by Assistant Secretary of the Interior D. W. Davis on a tour of personal inspection in which he will be accompanied by A. P. Davis, director, United States Reclamation Service. The two will leave Washington April 14.

Cities in Michigan May Incorporate as port districts hereafter under authority granted by an amendment to the state constitution approved by the voters of the state April 2. The measure had been defeated at two previous elections. A large favorable majority to the amendment was cast in Detroit in view of local interest in the proposed Port of Detroit.

The Chicago Zoning Ordinance, as prepared by a commission of twenty-one members which was appointed by the mayor in July, 1921, was adopted on April 5 by the unanimous vote of the Chicago city council. The chairman of the commission is Charles Bostrom, city building commissioner, and its zoning expert is Edward H. Bennett of Chicago.

Paralleling in a Measure the recent gift of Ambrose Swasey of Cleveland of $500,000, which made possible the organization of the Engineering Foundation, comes the bequest of a like sum to the furtherance of scientific study by Sir Alfred Yarrow to the Royal Society in London.

Probably the Longest of the Numerous minor railways which have been abandoned during the past few years on account of financial conditions is the 234-mile line of the Chicago, Peoria & St. Louis Ry., extending from Pekin, Ill., to East St. Louis. The Interstate Commerce Commission has authorized the receivers to abandon the line, which will be sold either as a whole or in part and will probably cease to be an operated line. Negotiations for purchase by larger connecting lines have been unsuccessful.

Am. Soc. C. E. Again Rejects Affiliation In Federated Engineering Societies

Total Adverse Vote 581 More Than in 1920—Three Districts Report Favorable Plurality—Total Vote 5,753

In the letter ballot canvassed April 6 the American Society of Civil Engineers again decisively voted against affiliation with the Federated American Engineering Societies. The vote was 2,112 for membership and 3,641 against it. In only three districts was there reported a plurality in favor of affiliation, these being Districts 7, 9 and 11. In District 1 (New York) the total resident vote was 854, of which number 688 rejected the plan of affiliation.

The accompanying map indicates how the country is divided into districts. In the table at the left is given the comparison of votes canvassed in 1920 and 1923. Since 1920 two new districts have been added.

AM. SOC. C.E. VOTE ON PROPOSAL TO JOIN FEDERATED AMERICAN ENGINEERING SOCIETIES

District	*1	**1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Yes.....	25	166	84	107	143	134	87	276	167	184	109	191	102	84	108	145	2,112
No.....	84	688	331	211	292	254	214	144	186	154	203	189	124	209	158	200	3,641
Plurality for.....	...	...	...	...	...	...	...	132	...	30	...	2	...	...	...	...	164
Plurality against..	59	522	247	104	149	120	127	...	19	...	94	...	22	125	50	55	1,693

*Foreign. ** Resident. Total Vote: 5,753. Total Plurality Against 1,529.

COMPARISON OF 1920 AND 1923 VOTE

	1920	1923	Difference
No.....	3,278	3,641	+363
Yes.....	2,330	2,112	−218
Total.....	5,608	5,753	145
Negative plurality.....	948	1,529	581

In 1920 defeated in 9 of the 13 districts.
In 1923 defeated in 12 of the 15 districts.

MAP SHOWING AM. SOC. C. E. DISTRICTS

Higher Court Holds N. Y. Dwelling Exemption Law Valid

The Appellate Division of the New York State Supreme Court in a decision handed down April 6 reversed the decision of the lower court and declared constitutional the act passed by a special session of the New York Legislature in 1920, authorizing the municipalities of the state to exempt low-cost dwellings and apartment houses from taxation for a period of ten years, provided that construction was begun prior to April 1, 1920. The decision of the lower court was given in *Engineering News-Record* March 29, p. 598. The Appellate Division in a unanimous decision put the tax exemption in the same class as other emergency legislation to relieve the housing situation passed by the special session of the New York Legislature in 1920 and sweepingly over-ruled the opinion of the lower court that (1) the tax exemption law delegated the powers of the Legislature and (2) gave special exemption from taxation because the act was permissive and some cities might while others might not accept its provisions. Whether another appeal will be taken has not been announced.

Spokane Engineers Discuss Licensing Bill

At a recent meeting of the Associated Engineers of Spokane considerable discussion was had of the bill before the Washington Legislature which provides for the registration of all engineers practising in the state. However, no recommendation was made in view of positive action taken by the local sections of the American Institute of Mining and Metallurgical Engineers and of the American Society of Civil Engineers. The former organization memorialized the state legislature with unqualified opposition to every form of registration and licensing of engineers as being contrary to American ideals of Freedom. The memorial deplored the attempt at license and characterized any legislation of the sort as an insult to the profession.

The local section of the Am.Soc.C.E. favored the bill as the lesser of evils inasmuch as the demand for registration and licensing seems to be the tendency of the times. The civils are reported to have considered the bill harmless outside of the heavy initial fee charged, and are reputed to have expressed the opinion that should they oppose this particular bill something worse might be presented.

Members of the local sections of the American Institute of Electrical Engineers and of the American Society of Mechanical Engineers have proven noncommittal.

The proposed Washington bill as passed in the house allows licenses to those practising within the state who register within six months after the bill becomes effective. An initial fee of $20 is required and $1 per year thereafter. Penalties are provided for calling oneself an engineer if not registered, and excludes from court work or state work those who are not registered.

Chicago Engineer Reinstated

The Chicago Board of Local Improvements has recently reinstated John B. Hittell, as chief engineer of streets. He was suspended Dec. 10, 1915, by the board as a result of a letter from the Civil Service Commission directing his suspension pending an investigation of the methods employed in awarding paving contracts. No investigation was held of Mr. Hittell's conduct but he did not get back his position.

He asked a year's leave of absence which was granted on condition that he submit his resignation (as a formality so the commission held at the time). At the end of the year the commission refused to reinstate him.

Finally a successful suit was brought in the Cook County Circuit Court which was carried by the city to the Appellate Court. The latter upheld the Circuit Court which was directed to mandamus the Civil Service Commission to restore Mr. Hittell to his former position with payment for back salary.

Mississippi River Bridge to Be Built by Twin Cities Jointly

C. M. Babcock, state highway commissioner of Minnesota, is chairman of a commission of five members created by the legislature of that state to direct the construction of a concrete bridge over the Mississippi River between St. Paul and Minneapolis near the government high dam. Other members of the commission are the presidents of the city councils and the city engineers, G. M. Shepard, St. Paul, N. W. Elsberg, Minneapolis. By the enabling act, which has been signed by the governor, each city is authorized to issue up to $800,000 for the project. The bridge is part of a joint Twin Cities program to serve the proposed Ford Motor Co. plant at the high dam with traffic facilities.

Contractor Ships Culvert Pipe by Parcel Post Mules

HOW a contractor made use of the parcel post for delivering construction material in an isolated mountain country is told in the accompanying picture. In his contract for work on the Klamath River Forest road, in California, the contractor was faced with a serious problem in distributing his culvert material in advance of the building of any sort of highway. The cost of transportation promised to be a big item until he hit upon the scheme of sending material by parcel post. This was done with as much of the stuff as seemed necessary and feasible. The picture shows parcel post mules making their way over the mountains loaded with corrugated iron culvert pipe. The new road penetrates a region which is inhabited by Indians living practically in the primitive fashion.

Port Authority Takes First Step to Develop Its Plan

On April 5 in response to a summons from the Interstate Commerce Commission, the representatives of the trunk railroads having terminals at the Port of New York, appeared before the Interstate Commerce Commission and the Port of New York Authority, sitting concurrently, to show cause why certain portions of their lines located along the New Jersey waterfront at New York should not be consolidated into one railroad as outlined in the Port Authority's plan for the development of the Port of New York, and called on that plan the New Jersey Inner Belt Line, Marginal Railroad No. 13.

The first part of the hearing lasted until the afternoon of April 7, and was devoted to the presentation of the case on the part of the Port Authority by counsel, by the examination of witnesses and by exhibits. The counsel for the Port Authority in presenting the case took the attitude that according to the law which created it, the Port Authority must first demonstrate to the Interstate Commerce Commission that the proposed belt line was both physically practical and economically desirable at this time, and that consequently the consideration of matters of policy and methods of operation would be a waste of the commissions' time until after it had decided the former question in the affirmative.

Marginal Belt Line No. 13 as called for in the approved plan for the development of the Port of New York is made up of 17 miles of existing railway tracks paralleling the New Jersey waterfront from Fort Lee on the north to Constable Hook on the south. The tracks in question are largely used now for interchange and interswitching and the Port Authority claims that the operation of them as a complete belt line serving all the railroads, industries and shipping interests along the New Jersey water-front can be effectuated without any new construction, that, in fact, such an arrangement was put into effect during the war.

Upon the conclusion of the presentation of the testimony by both sides the Port Authority will ask the Interstate Commerce Commission that if the Commission is of the opinion that the development of Marginal Railroad No. 13 is possible and economically desirable at this time, it will issue an order directing the railways concerned to take steps to create such a belt line.

The hearing adjourned on April 7 to allow the railroads to examine the testimony and exhibits before being called upon to reply.

Start Probe of Old New Jersey Highway Commission

Having confirmed Governor Silzer's appointment of the four-man, bipartisan highway commission, the New Jersey legislature will now probe the old highway commission, Attorney General Thomas F. McCran being delegated to conduct the investigation. The state has instituted suit in the Court of Chancery to recover $140,000 which, it is claimed, the state was mulcted of in the purchase of land for approaches to the proposed new $3,000,000 bridge between Perth Amboy and South Amboy.

Colorado Society Wants Local Engineer for Tunnel Board

W. M. McMechen, president of the Colorado Society of Engineers has addressed a letter to William P. Robinson, chairman of the Moffat Tunnel Commission urging the appointment of a local man as chief engineer for the commission. Part of the letter follows:

"As president of the Colorado Society of Engineers, I am directed to place before you, not only the protest of our society, but protests communicated to our secretary from prominent engineers of other state engineering bodies, against the appointment of an engineer from outside the state as chief engineer of the Moffat Tunnel Commission. The Colorado Society of Engineers, through the action of its president, wishes to go on record as being absolutely opposed to the importation of an engineer from outside the state, since it is possible to secure experienced and competent engineers in Colorado.

"The construction of the Moffat tunnel is peculiarly a Colorado project. It is a deliberate act by the citizens of the Moffat tunnel district to improve transportation facilities in a portion of the state whose future development depends upon the securing of better means of railroad communication.

"The Colorado Society of Engineers is not alone in taking this attitude. It is safe to say that the members of the other scientific and engineering societies of Colorado are practically united in their demand for the appointment of a Colorado man as chief engineer of the Moffat Tunnel Commission, and this statement rests upon the fact that a number of the most prominent engineers in Denver have communicated with the secretary of this society, and have expressed in positive terms their disapproval of the plan, known to be considered, of importing an Eastern man of the New York group.

"The secretary of the Colorado Society of Engineers has been informed that this proposal will be regarded by the engineering profession of the state as a direct reflection upon the profession and will be considered as a personal affront to its prominent members."

State Sanitary Engineers Meet in Washington, May 16-17

The fourth annual conference of state sanitary engineers will be held at Washington, D. C., May 16 and 17. Membership includes the chief sanitary engineers of state health departments and other chief sanitary engineering officials having charge of sanitary engineering work of the states, and three sanitary engineers of the United States Public Health Service. The meetings will be held at the United States Capitol Laboratory. A prominent part of the program includes a discussion on the proposed Treasury Department Water Standards, which will be opened by Surgeon A. J. McLaughlin of the United States Public Health Service. Most of the topics on the program relate to water supplies and allied matters, but sewage disposal and mosquito control, sanitation of bathing beaches, etc., will be up for discussion. Programs can be obtained from I. W. Mendelsohn, Assistant Sanitary Engineer, United States Public Health Service, Washington, D. C.

Col. Keller Resigns as D. C. Engineer Commissioner

Col. Charles Keller, a widely known officer of the Corps of Engineers, U. S. Army, who has served for the past two years as Engineer Commissioner of the District of Columbia, has resigned as a District Commissioner to undertake important duties in connection with hydro-electrical development on the Coast.

While Col. Keller is eligible for retirement, it is understood that he will ask at this time for a leave of absence only. It is understood that the Byllesby Engineering and Management Corp. has agreed to give him a five-year contract. Before signing the contract, however, and definitely retiring from the army, it is understood that Col. Keller prefers to familiarize himself more thoroughly with the character of the work he will be called upon to perform.

Throughout his engineering career, which began with his graduation at West Point, in 1890, Col. Keller has taken great interest in water-power development. As the representative of the War Department, he supervised most of the important installations at Niagara Falls and was the representative of the Department who assisted in the drafting of the Federal Water Power Act.

Hetch Hetchy Dam Is Now "O'Shaughnessy Dam"

The Board of Supervisors of San Francisco on March 26 adopted a resolution providing that the Hetch Hetchy Dam shall hereafter be designated as "O'Shaughnessy Dam" in honor of its builder. The resolution states that the dam is one of the largest structures of its kind in the world and will long endure as evidence of the knowledge and genius of its creator, M. M. O'Shaughnessy, city engineer of San Francisco.

The resolution provides "That as a monument of the great ability displayed in its creation and to perpetuate in the years to come the name of its builder said structure shall be designated and hereafter be known as O'Shaughnessy Dam" and also "that the Board of Public Works is hereby directed to have the aforesaid name suitably engraved upon the structure."

Michigan Joins Wisconsin in Lake-Level Suit Against Chicago

States attorneys and engineers of Wisconsin, Michigan, Minnesota and Indiana met March 19 and 20 in Chicago to discuss the suit started last year by Wisconsin against Illinois alleging lowered lake levels with damage to lake ports due to excessive withdrawel of water by the Sanitary District of Chicago. The purpose of the conference was to enlist the aid of three states to Wisconsin's suit. From reliable sources it is learned that Michigan was inclined to favor and join with Wisconsin, while the other two states were lukewarm on the proposition.

Three days previous to the attorneys' conference R. R. McCormick, editor of the *Chicago Tribune*, delivered an address of defense of the Sanitary District before the Western Society of Engineers.

Gen. William V. Judson Dies

Gen. William V. Judson, commander of the 38th Division during 1918, and later commander of the Port of Embarkation, New York, died in Florida recently aged 60 years. Gen. Judson was retired from the Corps of Engineers several months ago, his last official assignment having been division engineer of the Northwestern Division with headquarters in Chicago.

After two years at Harvard, Gen. Judson attended West Point, being graduated in 1888. He rose in the Corps until in May of 1917 he was made colonel. Soon after he was made a brigadier-general and placed in command of troops. Various stations which he occupied officially included membership on the Corps of Engineers Board of Rivers and Harbors, supervision of port improvement at Galveston and of Mississppi River improvements, instructor of military engineering at the U. S. Engineer School, and assistant to the Chief of Engineers.

During the Russo-Japanese War Gen. Judson was military attache with the Russian Army. Later he was placed in charge of the light-house construction and harbor improvements on Lake Michigan, which station preceded a term as engineer commissioner of the District of Columbia. He went to Russia in 1917 as a detached officer, but remained there in 1918 as military attaché and chief of the American Military Commission.

He was a member of the American Society of Civil Engineers and of various social clubs in Washington and Chicago.

New Sewage-Works Program Arranged for Philadelphia

To add borrowing capacity to Philadelphia by releasing an alleged commitment of $29,000,000 of expenditure to complete the far-looking sewage-disposal program authorized in 1915 by the State Department of Health, a revised program has been arranged between the city and the state department named under which the specific commitment against the city's borrowing capacity will be reduced to $9,000,000 to be expended at the rate of $2,250,000 a year during the next four years, provided that the electors approve a $9,000,000 loan to be submitted to them at an early date. The agreement provides for extensions of the time limit for the completion of sewage-works beyond the date stipulated in the 1915 permit and for still further extensions, all contingent upon due diligence in prosecuting construction now agreed on and in submitting plans to carry out by stages the full program of 1923.

The 1915 permit was based upon plans for three sewage-works, intercepting sewers and pumping plants estimated to cost $34,600,000. After the city had been operating for six or seven years under the permit and had appropriated $5,525,000 to carry out the program, the city solicitor, last December, rendered an opinion that the remaining $29,075,000 called for by the program, most of which would not be expended for years to come, was a charge against the city's borrowing capacity. It is expected one of the three proposed sewage-works will be completed this summer.

Colorado Signs River Pact

On April 2 Governor Sweet, of Colorado, signed the Colorado River pact which had been accepted by both houses of the Colorado Legislature. This leaves only the State of Arizona not signatory to the pact, which is between the States of California, Utah, Wyoming, New Mexico, Arizona, Colorado, and Nevada. As noted in these columns some weeks ago, the Arizona Legislature adjourned without ratifying the pact after a vote of 22 to 22 in the Assembly. It is now reported that the Governor of Arizona is trying to call an extra session for reconsideration of the treaty.

The whole subject of the Colorado River power development, it is now announced, will be taken up by the Federal Power Commission at a meeting to be held April 18. The Commission has advised the Governor of Colorado, according to a previous promise, that consideration is to be given the application of James B. Girand for a license to develop the project at Diamond Creek on the Colorado River. It was stated in the letter to the Colorado Governor that any license issued to Mr. Girand would carry with it a condition that the use of the water for power purposes would have to be subordinated to its use for irrigation.

This carries with it the intimation that the Commission may act on the Girand application at its forthcoming meeting.

It is fully expected that the discussion will include the whole Colorado River question. Any discussion of the Diamond Creek project carries with it the necessity of considering the Glen Canyon application of the Southern California Edison Co. It also is believed that the Flaming Gorge project of the Utah Power and Light Co. will be brought up, since that company is very anxious to utilize the coming field season to do the necessary drilling to establish foundation conditions. The Kremmling project of the Denver Gas and Electric Co. also is to be considered.

Baltimore & Ohio Starts a New Grain Elevator

The Baltimore & Ohio R.R. Co. has started the construction of a new grain elevator at its Locust Point Terminals, Baltimore, Md. The new elevator will have a capacity of 3,800,000 bushels and is so designed that storage bins for 6,000,000 bus. additional can be built as required. The elevator proper will be built of concrete. The grain handling equipment will be the most modern available including car dumpers, power shovels, grain cleaning and drying equipment, and a gallery system equipped with belt conveyors for the delivery of grain from the elevator to the ships. The total cost of the work, including the pier improvements and yard changes will be $5,500,000.

St. Paul Ry. to Serve Ford Plant

A 4½-mile branch or spur traversing the heart of the city of St. Paul, Minn., is expected to be built this year at a cost of $700,000 by the Chicago, Milwaukee & St. Paul Ry., in order to serve the Ford plant which is being arranged for near the high dam on the Mississippi River. An ordinance has been passed by the city giving the railway company permission to cross the streets at grade.

Burlington Ry. Has Big Program for 1923 Improvements

The 1923 program for improvement work on the Chicago, Burlington & Quincy R.R. aggregates $50,000,000, of which $25,000,000 is for additions and betterments, including equipment, and $25,000,000 for maintenance of way and structures. These figures compare with $19,370,000 and $20,769,379 respectively for 1922. In thus planning its work the railroad is not only providing for the business in sight but to some extent anticipating future developments. In this large program are the following items: About 30 miles of second track, including some realignment, $2,200,000; enlargement of yards, $800,000; shops, roundhouses and engine terminals, $1,300,000; water and coaling stations, $350,000; relaying rails, including 44,000 tons of new rails, $1,268,000; about 160 miles of automatic block signal installations, $420,000; replacing temporary bridges, $1,458,000, of which $860,000 will be for replacement in permanent form. As to equipment, sixty heavy freight locomotives and 7,300 cars have been ordered, to which will be added the purchase of 1,000 stock cars and 200 combination coal and construction cars. Arrangements are being made also for heavy repairs to 6,000 coal cars.

Fate of Water Supply Bills in New Jersey Legislature

To afford relief to municipalities and water companies in Union and Somerset Counties the New Jersey Legislature passed bills just before adjournment authorizing municipalities to contract for a water supply with combinations of local companies and giving cities in the counties named power to take over and enlarge the works of private companies. For months past the municipalities in the section indicated, including Elizabeth and Plainfield, have been much concerned over possible water shortages and some of the companies have pleaded financial inability to provide additional supplies under existing conditions.

A bill providing for a commission to join like commissions in New York and Pennsylvania in an investigation of the water resources of the Delaware River was passed, but its effectiveness is conditioned on an appropriation by the legislature—which presumably was included in the annual appropriation bills.

After long and bitter contention the status of the Bayonne project for taking a water supply from the Ramapo River and the jurisdiction of the State Board of Conservation and Development on the one hand and on the other that of the North Jersey District Water Supply Commission were left unchanged. The immediate intent of the bills at issue was to require Bayonne to get the approval of the district commission for its proposed dam on the Ramapo River, a tributary of the Passaic, and conduit therefrom to Bayonne. The state board has approved these plans. It was alleged that the East Jersey Water Co., which through an affiliated company now supplies water in bulk to Bayonne, worked against the legislation. Clyde Potts is engineer for the Bayonne project and was one of the storm centers in the legislative contest.

Illinois Waterway Project Halted

A court decision as to condemnation proceedings for the site of the proposed Starved Rock lock, near Utica, Ill., is reported as likely to seriously delay progress on the long-projected waterway to connect the Chicago drainage canal with the Illinois River. According to the decision of the local county court the state cannot bring condemnation suits until all towns along the route have approached the construction of the waterway. The case will now go to a higher court.

Starrett Demurs to Indictment on War-Fraud Charge

Indictments found against eight individuals in connection with war-time contracts have been attacked by William A. Starrett, one of the defendants, who has filed a demurrer charging the actions have been brought by the government purely as political procedure. The demurrer, filed in the District of Columbia Supreme Court, says that, inasmuch as the subject of the indictment was believed political, the criminal court had no jurisdiction.

Illinois Central Will Complete Chicago Freight Yard

Work is to be pushed vigorously on the new Markham freight yard of the Illinois Central R.R., at Chicago and it is expected to have the greater part of the yard in service before the end of 1923. This yard, just south of Harvey, Ill., 18½ miles from the Chicago passenger terminal will be the main-line freight terminal for the Chicago district, where inbound trains will be broken up and outbound trains made up. All movements north of this yard will be switching and transfer service. This freight terminal was begun in 1918 (see *Engineering News-Record*, Aug. 15, 1918, p. 313) but work has been delayed by various causes. However, about $2,500,000 has been spent, mainly on the filling to raise the site to grade. The sum of $6,000,000 will be required for completion.

For northbound and southbound traffic there will be two separate units, each consisting (for the present construction) of a 10-track receiving yard, a 10-track departure yard and a classification yard with hump for gravity switching. The northbound classification yard will have sixty tracks for 2,400 cars and the southbound yard will have forty tracks for 2,000 cars. Double the number of tracks in each yard is provided for by the general plans. In addition there will be an engine terminal and a transfer station for rehandling L.C.L. freight.

Since the project was started it has been decided to elevate the main line along the west side of the yard in order to eliminate all grade crossings, including the crossing of the Grand Trunk Ry. and Baltimore & Ohio R.R., at Harvey, where a new passenger station will be built. This Harvey improvement will require about 1,000,000 cu.ft. of filling and will cost about $1,200,000.

The design and construction of this freight terminal yard are under the direction of F. L. Thompson, chief engineer, Illinois Central R.R.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Spring Meeting, New Orleans, La., April 18-20.

NATIONAL CONFERENCE ON CITY PLANNING, New York; Fifteenth Conference, Baltimore, April 30-May 2.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; Annual Convention, Norfolk, Va., May 7-9.

NATIONAL FIRE PROTECTION ASSOCIATION; Boston; Annual Meeting, Chicago, May 8-10.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Detroit, Mich., May 21-25.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Annual Meeting, Atlantic City, N. J., June 25-29 or 30.

The Northeastern Section of the American Society of Civil Engineers, Boston, will be addressed April 30, on "The Use of the Airplane in Topographic Mapping" by Col. C. H. Birdseye, chief topographic engineer of the U. S. Geological Survey.

Personal Notes

PROF. HUDSON B. HASTINGS, formerly of Bowdoin College and of Reed College, Portland, Ore., has been elected to the chair of administrative engineering at Yale University. This course was organized in the Sheffield Scientific School four years ago and sprang out of the belief that there was an increasing demand for young men of ability trained so that they would be able to start their careers not on the purely technical side but more directly on the administrative or executive side. It was also recognized that a broad, sound training in the principles of economics and related subjects is a valuable asset to a man in administrative work. Prof. Hastings will assume his duties at the beginning of the next academic year.

MARTIN A. PRESTON, chief engineer and secretary-treasurer of Brown, Preston & Derrick, Inc., architects and engineers of Detroit, Michigan, has disposed of his interest and resigned as an officer and director of the corporation. Mr. Preston has not definitely determined upon his future activities but advises that they will be along engineering and construction lines.

BIRGER F. BURMAN has resigned as chief engineer of the New England Oil Refining Co. He leaves at the time of completion of an extensive building program inaugurated about two years ago when he became connected with the company. Formerly he was for several years connected with the Atlantic Refining Co. (to a large extent rebuilding the Pittsburgh refinery), and with the Jones & Laughlin Steel Co., at Pittsburgh. No announcement has been made of his plans for the future.

H. V. LUCAS has been appointed as vice-president of the Harrison Construction Co. Inc., contractors and engineers with offices in Virginia Railway & Power Building, Richmond, Va.

HENRY E. ELROD, consulting engineer of Dallas, Texas, who recently moved to Santa Monica, Calif., because of ill health, has been acting as consulting sanitary engineer to that city. Aside from that he is doing some consulting work, specializing in sanitary engineering with particular reference to sewage and garbage disposal.

HAZEN & WHIPPLE, civil engineers, New York City, announce the removal of their offices to 25 West 43rd St.

J. HAROLD RAPP CO. is a new engineering firm established in Pittsburgh, Pa., with headquarters at 636 Penn Ave. The firm will carry on a business of structural engineering, making designs for industrial plants, etc. Officers of the company are: J. Harold Rapp, president; Raymond E. Lightner, vice-president; William J. Erdner, treasurer, and Albert T. Eyler, secretary.

L. M. EDWARDS, for the past three years superintendent of the Paradise Irrigation District, Butte County, Calif., has resigned and J. A. ALLEY, of Paradise, Calif., named to fill the vacancy.

RAY KLEIN, former secretary of the Oregon State Highway Commission, Salem, Ore., has been appointed State Highway Engineer effective April 1, 1923. He will still continue as secretary for the commission. He succeeds Herbert Nunn, recently resigned.

E. R. GRAY, city engineer of Hamilton, Ont., will resign April 15 in order to take a position as manager of the park board of Hamilton. W. L. McFaul, now assistant city engineer, has been appointed by the city council to succeed Mr. Gray.

LUTHER R. TILLOTSON has been appointed state highway engineer of Kansas by Governor Davis to succeed M. W. WATSON, who recently resigned. Mr. Tillotson is a graduate of Kansas University. He was a captain overseas in the 110th Engineers and has been connected with road machinery and materials companies since leaving the service.

EDWARD H. SARGENT, formerly associated with the Bureau of Water Power in the New York state engineer's office, has been appointed engineer for the Hudson River Regulating District.

HECTOR MACNEIL, assistant engineer of the Canadian National Rys., has been named resident engineer, Division Four, of the Longlac-Nakina cutoff.

DAVID ELWELL has been appointed manager of the New York office of Lockwood, Greene & Co., to succeed Gen. W. H. Rose, whose resignation was announced in these columns last week. Mr. Elwell is a graduate of Boston "Tech," and has served the Edison Electric Illuminating Co. of Boston; the Westinghouse Electric & Manufacturing Co., at East Pittsburgh; was superintendent on electrifications of the New York division of the N. Y., N. H., & H. R.R.; and for four years was sales engineer for the Westinghouse company in New York. He has been in the New York office of Lockwood, Greene & Co., since 1920, having been transferred there from the Boston office.

Obituary

FRED A. MURRAY, chief engineer of the Porto Rico Irrigation Service, stationed at Guayama, Porto Rico, was shot and killed in his office the latter part of March by a discharged native employee. Mr. Murray had been chief engineer of the Porto Rico Irrigation Service during the past three years, having previously served for several years as assistant chief engineer.

EDWARD F. FLAHERTY, construction engineer, of Hollywood, Cal., died April 1, aged 46 years. He was at one time assistant to the chief engineer of the Santa Fe R.R. He was a member of the American Society of Civil Engineers.

COL. J. B. BREATHITT, aged 79, for six years a railroad commissioner of Missouri, his native state, died in Tucson, Ariz., April 2. For 15 years he was commercial agent of the Southern Pacific R. R. of Mexico.

H. H. STOEK, professor of mining engineering at the University of Illinois, died suddenly March 1. After graduating from Lehigh University in 1887 he became assistant engineer of the Susquehanna Coal Co., returning to the university in 1900 as an instructor. In 1903 he became e itor of *Mines and Minerals* and in 1909 he went to the University of Illinois as professor of mining engineering.

THOMAS M. VINTON, one of the pioneers in reinforced-concrete construction in the East and formerly of the firm of Tucker & Vinton, New York City, died in Mazatlan, Mexico, recently, where he had gone last year for his health. He was 48 years of age. Mr. Vinton, after leaving Massachusetts Institute of Technology, engaged in various engineering and construction work in New York, having been a timekeeper on the Mills Hotel No. 1, one of the first reinforced-concrete buildings in New York City. Practically his entire professional career was connected with concrete work. At the time of his death he was not active in business, but up until last summer he had been with the Trout Concrete Tile Corp., manufacturers of concrete products.

WALTER HUNTER, civil engineer and associate engineer of the California State Highway Commission, was killed April 1 by a stroke of lightning while standing in front of the Stockton (Calif.) Golf and Country Clubhouse, with a steel golf club in his hand. Mr. Hunter had served as Stockton's city engineer for several years before taking the state position. He was active in reclamation and flood-control work and was assisting in planning Stockton's proposed new harbor.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Advice Given on Proper Care of Concrete Paving Mixer

"Clean it—Tighten it—Grease it." These are the instructions which Burton Franklin, general Southern agent for the Multi-Foote concrete paving mixer, has issued in the form of a printed folder showing how a contractor, by proper care, can make his paving mixer last longer and do more work.

The modern paver, Mr. Franklin states, is built to mix more than 2 tons of material to a batch and is a machine of many parts and many bearings. Every night the accumulation of dirt and cement should be removed. A few minutes with the hose will do this work easier and better than if the machine is left for several days until the concrete hardens. Every night and also at noon during hot weather the inside of the mixing drum should be cleaned by turning within it for a few minutes a small quantity of stone with a liberal amount of water.

Loose bolts and nuts should be tightened. This job should be a daily duty. A loose bearing does its evil work throughout the whole machine and often the first sign of trouble appears in a part far removed from the loose bearing.

Oiling and greasing should be attended to regularly. On the Multi-Foote paver there are about 60 places that require oil and grease and if any of them is neglected the machine will not function properly. It is better to oil too much than too little.

Winners Announced in Shovel Company's Prize Contest

To Herman Huebscher, general contractor, St. Paul, Minn., has been awarded the first prize of $100 and a gold watch in the contest conducted by the Erie Steam Shovel Co., Erie, Pa., for the best upkeep cost data on power shovel operation. The board of judges consisted of Arthur S. Bent, of Bent Brothers, general contractors, Los Angeles; Halbert P. Gillette, editor, "Engineering and Contracting"; and Arthur C. Vicary, vice-president of the Erie Company. Second and third prizes, consisting of watches and $50 and $25, respectively, were won by A. B. Cox, assistant general manager, Novaculite Co., Olive Branch, Ill., and F. J. Chaplin, of W. A. Gould & Bro., Brisbin, Pa. Seventeen other prizes ranging from $20 to $5 were awarded. The contest, calling for statements of experience as to the operating costs of power shovel work, drew about 300 entrants.

Construction Equipment Exported

Figures from the U. S. Department of Commerce indicate the following exports of construction equipment for the month of January, 1923: 31 concrete mixers valued at $23,624; 29 conveyors of the bucket, chain or belt type, valued at $24,229; other exports of road-making and construction equipment, not classified, 400,000 lb. at $63,600.

Featuring of Record Runs Elicits Further Comment

Supplementing the discussion in last week's issue (p. 643) other equipment manufacturers this week state the policies of their organizations.—EDITOR.

By Morgan Ramsay
Assistant to President,
Bay City Dredge Works, Bay City, Mich.

IT HAS always been the policy of this company to refrain from mentioning record runs either in advertising, or articles for publication. We occasionally have referred to records made by Bay City equipment when in actual conversation with interested parties; in such cases the underlying conditions can then be thoroughly explained.

Our policy is to be conservative rather than to claim records, as we believe it makes a greater hit with the contractor or engineer to find that a machine actually does more than was cliamed for it, than to find it does *just* what he had expected or what was promised. There is no doubt but that the contractor or engineer can easily get the wrong impression of a machine and its possibilities by reading record-run publicity.

As a matter of fact, a record run does not necessarily mean a thing, when all of the elements entering into it are concerned. There are practically no two construction jobs, particularly in the drainage and excavation field, which are similar, or which can be handled in connection with similar labor, weather or soil conditions, all of which are factors which assist or hinder record yardage.

By H. B. Bushnell
Sales Engineer,
Western Wheeled Scraper Co., Aurora, Ill.

IT HAS always been the policy of the Western Wheeled Scraper Co. to refrain from publishing or using in advertising matter any data or statement that could in any way work to the disadvantage of the contractor.

The use of cost data in an advertisement is scarcely ever complete enough to be of real service and is dangerous in the hands of the inexperienced operator.

Production records based upon the actual working conditions, and truthfully stated, give information of value if properly presented. If, however, these records are based upon special speed tests, where the conditions are ideal, and where days are taken to prepare for the tests—and other days spent to repair the outfit afterward—naturally such production are dangerous and misleading. Our advertising and general business policies are very conservative and do not sanction the use of production records that might be technically true and yet be misleading from a practical standpoint.

(To Be Continued Next Week)

To Confer on Fewer Grades of Asphalt for Road Work

Producers to Act with Dept. of Commerce in Industrial Waste Elimination Program

Washington Correspondence

As the result of interest in the subject stimulated by recent articles appearing in *Engineering News-Record*, the Division of Simplified Practice of the U. S. Department of Commerce, at the immediate suggestion of the Asphalt Association of New York City, has issued invitations to leading producers of asphalt and allied interests for a preliminary conference to be held in Washington April 24 to discuss a possible reduction in the variety of grades of asphalt for roads and pavements and other phases of co-operation as part of Secretary Hoover's program for the elimination of waste in industry.

Following the publication of the article above referred to, this journal called upon a number of the country's leading highway and paving engineers for their opinion as to the feasibility of securing more uniformity in specifications and reducing the thirty or more grades of asphalt ordinarily demanded to about seven. Almost without exception the asphalt users endorsed the project for fewer varieties.

This first meeting is primarily to secure agreement as to standards among the asphalt producers and at a later date a general conference, to include both producers and representatives of the state highway departments, the federal government, and city and county road and paving officials, is planned.

Other Conferences Called

The division also has called a preliminary conference looking toward simplification in sewer pipe, drain tiles and other clay products, which will be held April 23. Among associations which will be represented are the Clay Products Association, the Eastern Clay Products Association, the American Society for Testing Materials and others.

A conference of face brick interests will be held May 11 by representatives of the Face Brick Manufacturers' Association, the Structural Service Committee of the American Institute of Architects and other interests, at the Simplified Practices Division to discuss the work of the manufacturers' association toward standardization. The association, through a recent survey, found 54 sizes of face brick being turned out, many with only slight variations, resulting in increased production costs.

Decision on Hillside Brick

The Standing Committee of the Paving Brick Conference, organized in 1922 when many varieties were eliminated, met at the Department of Commerce March 27 and as the result of the 1922 production chart which showed that it represented only 4.1 per cent of the output, voted to eliminate from the list of standards Hillside brick (repressed) 4 x 3½ x 8½ in. It was decided to call upon the American Engineering Standards Committee for an investigation into the value of the services of the various types of paving brick. A motion to eliminate two other sizes from the standard list was lost. The variety survey will be continued throughout 1923 by the National Paving Brick Manufacturers' Association.

Manufacturers Take Space for Water-Works Exhibit

With 50 per cent of the members of the Water Works Manufacturers' Association still to be heard from on April 6, about 75 per cent of the exhibit space available at the annual convention of the American Water Works Association in Detroit May 21-25 has been applied for, according to information received from George McKay, of the Leadite Co., Philadelphia, chairman of the Exhibit Committee. The number of exhibitors, to date, is 44, and indications are that late applicants for space cannot be accommodated. Among the products to be shown are valves, water meters, pipe joints, chlorinating apparatus, pumping equipment, and fittings of various types.

Special Train for Water-Works Convention at Detroit

The transportation committee of the American Water Works Association has arranged for a special train to Detroit for the annual convention in that city, May 21-25. It will leave New York at 2 p.m., May 20, over the Delaware, Lackawanna & Western R.R., arriving in Detroit via the Michigan Central R.R. May 21, at 7:10 a.m. Reservations should be made with the chairman of the transportation committee, Walter H. Van Winkle, 50 Church St., New York City.

Meter Specifications Adopted by N. E. W. W. Association

After minor changes and subject to approval of its sister association, the New England Water Works Association on March 13 adopted the specifications for current, compound and fire-service types of cold-water meters recommended by the Joint Committee of the American and New England Water Works Associations. Joint specifications for disk meters were adopted in 1921. Charles W. Sherman, of Metcalf & Eddy, Boston, is chairman of the Joint committee.

Business Notes

EGLESTON BROS. & CO., INC., dealers in iron and steel, including reinforcing bars, shapes, plates, galvanized sheets and tool steel, have moved from 166 South St., New York City, to their new plant at Borden Ave. and Mount St., Long Island City, where new buildings cover a site of about 1¼ acres.

TRAYLOR-DEWEY CONTRACTING CO., Allentown, Pa., announces a re-incorporation under the name of the Cement-Gun Contracting Co. The firm will specialize in construction and repair with the cement gun and in addition is prepared to build reservoirs and other plain or reinforced-concrete structures.

CHARLES S. WILLIAMSON, vice-president of the Mead-Morrison Mfg. Co., died in Chicago, March 31. He was born at Cleveland, Ohio, in 1874 and was graduated from the Case School of Applied Science in 1895. He had experience with several mechanical engineering firms and specialized in the design of heavy machinery for material handling and conveying.

CANADIAN WESTINGHOUSE CO. LTD., of Hamilton, Ont., has received what is stated to be the largest single order for electric generators ever placed with a Canadian company. The contract calls for the construction of eight generators of the vertical water-wheel type for the power development plant at the outlet of Lake St. John on the Saguenay River in Quebec, which is being constructed by Sir William Price of Quebec and J. B. Duke of New York. Each generator will be of 30,000 k.v.a. capacity and their total production will be 300,000 hp.

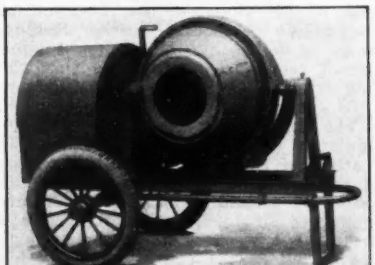
STEARNS MOTOR MANUFACTURING CO., Ludington, Mich., manufacturer of industrial engines used in the Bear tractor, Thew shovel, Universal crane, Lombard tractor, Overland crane, Henneue tractor, Hadfield-Penfield crane and locomotive, Stinson tractor, and others, announces the opening of a sales and service branch office in Detroit, at 3420 McDougal Ave. Paul J. Kraft, an engineer who has represented the Wheeler-Schebler Carburetor Co. for a number of years, will also have charge of the Stearns' Detroit office.

N. D. DOANE, chief chemist, Indianapolis Water Co., has resigned to join the sales staff of the Wayne Tank & Pump Co., in the water softening department. His headquarters are Old Colony Building, Chicago.

Equipment and Materials

Small Tilting Mixer Has Same Features as Larger Machine

The same features of design that have characterized its larger mixers have been incorporated by the T. L. Smith Co., Milwaukee, in its new half-

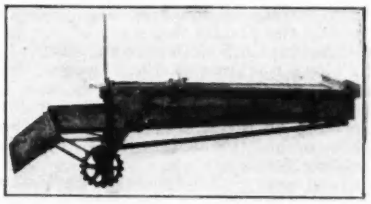


bag tilting mixer just placed on the market, as announced in last week's issue. This machine designated as No. 375, with a batch capacity of 3¾ cu.ft. of 1:3:6 mix with materials containing the usual 40 per cent voids, is equipped with the double-cone drum, central gear ring and roller track, and independent tilting frame. For the double-cone drum feature speedy discharge is claimed, the drum returning automatically to the mixing position as soon as the tilting lever is released.

The main drive gear and engine pinion of the new machine are machine cut and the bevel drive pinion is made of 40 per cent carbon electric steel. The power plant consists of a 1½-hp. Fuller & Johnson gas engine equipped with magneto and is completely housed. The mixer is built in two models, one equipped with two pressed steel wheels fitted with clincher rims for Ford 30 x 3½-in. pneumatic tires, and the other with four steel wheels, 24 in. in diameter and with 3-in. grooved treads. The two-wheeled model with pneumatic tires weighs only 1,100 lb. and is equipped with a hauling stub for attachment as a trailer, to an automobile or truck.

Feeder for Bucket Elevator Aids Unloading of Cars

To speed up the unloading of freight cars with bucket elevators the Good Roads Machinery Co., Kennett Square, Pa., has designed a feeder in the form of a steel box or covered chute 11 ft. 4 in. long, 20 in. deep and 32 in. wide,



which is set under railroad tracks and at right angles to them as shown in the accompanying photograph. Crushed stone, sand, gravel or other material is discharged from the bottom of the railway cars into the trough of the feeder, which is slightly inclined and given an oscillating motion by an eccentric drive from the bottom of the elevator.

The top of the feeder consists of two flat steel gates set in slides to control the amount of opening. It is claimed that the feeder cannot be choked no matter how much material drops on top of the opening. This feeder is designed to meet the objections sometimes raised by railroad officials to the digging of large pits underneath their tracks to assist in car unloading. The ditch required for the feeder need never be deeper than 2 ft.

A. B. Wood Suction Pump Patent Upheld by Court

Validity of the A. B. Wood patent on the pumps designed by him for lifting water and sewage and for use in suction dredging where large solid objects like blocks of wood, stumps, etc., present themselves for passage through the pumps has been upheld by the United States Court of Appeals following appeals and cross-appeals from the District Court for the Southern District of Alabama (Atlantic, Gulf & Pacific Co. *vs.* Albert Baldwin Wood; decision filed March 1).

The decision holds that a dredge pump built and used by the company above named is an infringement on the Wood patent, even though the Wood pump mentioned in the suit had only two vanes, as compared with three in the alleged infringing pump and the vanes in the two pumps had other dissimilar features. One of the claims in the Wood patent, the higher court points out, is for a plurality of vanes. The lower court ruled that "Vanes K and Gaylord 4" infringed the Wood patent but that "Vane J with or without the lugs attached," did not. The higher court holds that all three vanes infringe the Wood patent.

Intrusion Waterproofing Process Injects Plastic Compounds

For the waterproofing of engineering structures such as tunnels, shafts, foundations, retaining walls, dams and reservoirs the Weber Engineering Corporation, New York City, has developed the "Intrusion" process in which a plastic compound is forced under air pressure from an injector to fill voids and form *behind* the structure a water seal, the feature of which is that it remains in a plastic state instead of setting up hard like cement grout. Among advantages claimed for the process are the cheapness of materials, as compared with the use of portland cement, and the fact that even under conditions where vibration or settlement tends to open up seams filled by the grouting process the plastic character of the material compound enables it automatically to close up any cracks or pores that might develop. The result is said to be equivalent to a membrane waterproofing on the outside of the structure with the additional advantage of a self-healing feature.

The method is especially applicable to conditions where the ground water contains impurities such as sulphur or salt in solution which might affect the hardening of a portland cement grout. Where conditions are suitable, however, a special clay compound is used, but the process may be employed with such filling materials as asphaltum or tar preparations, sulphur, paraffine, fluosilicates, used either hot or cold. For the application of the method an injector has been developed. It follows the general principle of a grouting machine, but has special features adapting it to the handling of a plastic material.

Carl Weber, who heads the organization bearing his name, has been engaged on the development of his intrusion waterproofing method for the past three and a half years. He was formerly president of the Cement-Gun Construction Company of Chicago, and is the founder and ex-president of the Weber Chimney Company. He is also a director of the Weber-Bau A. G. in Berlin, Germany. The process outlined has been applied to a variety of engineering structures both in this country and in Europe.

Publications from the Construction Industry

Bridges and Buildings—ANTHRACITE BRIDGE CO., Scranton, Pa., describes the design and construction of the South-to-East bridge at Scranton, in a 22-p. booklet. The bridge is of reinforced concrete with a total length of 460 ft. 8 in., and a clear span of 201 ft. 8 in. for the main arch. The company illustrates also some of its other types of construction, including industrial and business buildings.

Drill Steel Handbook—SULLIVAN MACHINERY CO., Chicago, has issued an 80-p. illustrated handbook dealing with the selection, heating, forging and tempering of rock drill steel. The text also contains instructions for the care and use of drill sharpeners and drill steel furnaces. The book contains a great deal of practical information and is of a size that fits in a coat pocket.

Steel Paving Guards—W. S. GOODWIN CO., INC., Baltimore, in a 31-p. illustrated booklet, shows how its steel guards may be employed to eliminate wear at the edges of pavements or along street-car rails. The guards, it is claimed, reinforce the paving base, hold the surface rigid and prevent lateral movement of the surfacing material.

Overhead Conveying System—CHISHOLM-MOORE MANUFACTURING CO., Cleveland, has issued two illustrated pamphlets describing its Atlas overhead track system for factory and shop transportation. The track is suspended from heavy steel hangers. Trolleys equipped with high-speed hoists are made in capacities of from ½ to 2 tons and with two, four, and eight wheels respectively. The overhead track may be fitted with two-way or three-way switches. About fourteen pages of one of the pamphlets are devoted to sketches of installation details.

Power Shovels—THEW SHOVEL CO., Lorain, Ohio, has just issued the first two folders of a series on power shovel construction. Each unit of the Thew shovel is discussed, beginning with the boom and including the turntable, truck, etc.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Production and Material Stocks in Eight Cities

Record Pig-Iron Output—Steel Ingot Rate Above March, 1920—Lumber Normal—Brick Stocks Lower

Iron and Steel—Pig-iron output during March reached a record total over 3,521,000 tons compared with the war time peak of over 3,508,000 tons in October, 1916. The steel industry is operating at better than 90 per cent of capacity as against 65 per cent one year ago. Steel ingot production during March proceeded at an annual rate of 45,000,000 tons, or somewhat above the record rate of March, 1920.

Actual tonnage figures reported by the American Iron and Steel Institute for the first quarter periods since 1921 are given as follows:

	1923	1922	1921
January	3,251,694	1,593,482	2,203,186
February	2,919,017	1,745,022	1,749,477
March	3,402,007	2,370,751	1,570,978

Unfilled orders on hand, March 31, as reported by subsidiary companies of the United States Steel Corporation, amounted to 7,403,332 tons.

Lumber—Total production for the entire country as reported to the National Lumber Manufacturers' Association, reached 958,883,437 ft. for the four weeks ending March 24, as compared with 785,022,079 ft. during the four weeks ending February 24. March shipments of 1,051,222,605 ft., exceeded those of the preceding month by 70,369,967 ft., while orders totaling 940,072,143 ft. fell 102,580,797 ft. under February. Production now stands a trifle above normal with shipments 108 per cent and orders 92 per cent of normal production. Output was 20 per cent below normal during the week of Apr. 1, 1922.

Cement—Production began to increase in January, advancing from 7,704,000 bbl. to 8,085,000 in the following month. Shipments recovered from the seasonal slump in December, increasing from 4,858,000 bbl. that month to 5,419,000 in January and 5,963,000 in February of the current year. Reserve stocks at mills, however, began to increase in October with 4,000,000 bbl. on hand, advancing steadily to 13,592,000 bbl. available Mar. 1, 1923.

Brick—Reports from members of the Common Brick Manufacturers' Association of America show a marked increase in orders on the books with a slight falling off of stocks on hand. Due to weather conditions, fully one third of

Minimum Wage Act Invalid, Supreme Court Declares

In a decision announced April 9 and generally regarded as one of the most far-reaching that the court has ever made, the United States Supreme Court by a vote of 5 to 3, declared unconstitutional the law passed by Congress fixing the minimum wage for women and minor girls in the District of Columbia. Associate Justice Sutherland, in delivering the majority opinion of the court, maintained that the law interfered with the liberty of contract guaranteed under the constitution.

The majority opinion referred to the minimum wage act as follows: "The feature of this statute which, perhaps more than any other, puts upon it the stamp of invalidity is that it extracts from the employer an arbitrary payment for a purpose and upon a basis having no casual connection with his business or the contract or the work the employee engages to do. The declared basis is not the value of the service rendered, but the extraneous circumstances that the employee needs to get a prescribed sum of money to insure her subsistence, health and morals."

In conclusion the court pointed out that "if in the interests of public welfare the police power may be invoked to justify the fixing of a minimum wage it may, when the public welfare is thought to require it, be invoked to justify a maximum wage."

The decision, it is predicted, will establish a nation-wide precedent, inasmuch as minimum wage laws have been enacted by more than a dozen states, six of which, consisting of New York, California, Oregon, Kansas, Wisconsin and Washington, got permission to intervene in the foregoing case as "friends of the court."

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

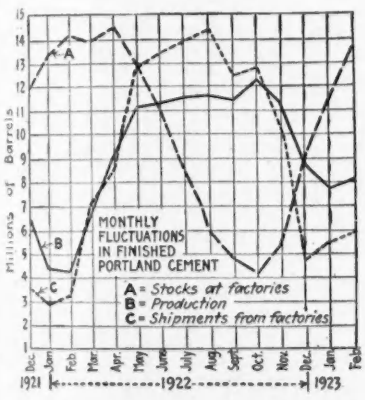
Stocks on hand in approximate figures, example: (Lumber, Minneapolis, 85,000,000 ft.); time required for delivery of carload lots to city job, example: (hollow tile, Atlanta 5 days); and stocks on hand in general terms, example: (sewer pipe, Philadelphia, stocks low.)

	San Francisco	Los Angeles	Denver	Minneapolis	Detroit	Atlanta	New York	Philadelphia
Sewerpipe	Plenty	Sufficient	Del. 24 hr., local plant	Good condition	Plenty up to 36 in.	Del. take 5 @ 7 days	Plenty of sizes 6 to 22 in., incl., shortage over 24 in.	Stocks low.
Cement	Small reserve	No shortage	Normal	20,000 bbl.	Ample for present needs	40 cars	No shortage	Supply depleted
Lime	Stocks low	Enough	Plenty	Ample	Well supplied from local and Ohio plants	40 cars	Enough; demand increasing	Fair quantity on hand.
Common brick	Large quantities on hand	Ample	1,000,000	Plenty; shortage of face brick	Moderate supply in local yards	Plenty	Demand heavier than supply	No surplus
Hollow tile	Well supplied	No shortage	Stocks normal	Sufficient	Stocks Small	Del. take 5 days	Nearby plants; del. by water	Stocks low.
Lumber	Big shipments being received	Heavy reserves 25 mi. from city	Shortage at mills	Large for the season 85,000 M. ft.	Dealers' stocks moderate	Plenty	Del. take 6 @ 8 weeks from mill	Demand greater than available supply
Asphalt	Extensive native reserves	Plenty	About 10 cars	Enough	Plenty; del. quick	Enough	Heavy reserves in N. J.	Plentiful
Structural steel	Good in spots	Enough in warehouses	Warehouse stocks sufficient	Meeting all demands	No shortage	3 @ 5 cars	Builders having difficulty in obtaining steel	Mills unable to make quick shipments

the plants in the Northern part of the country were closed during March. Burned brick on hand, as of March 1, totaled 185,094,000 as against 199,449,000; orders reached 302,905,000, compared with 238,486,000 for the month preceding.

San Francisco—Fairly well stocked with track supplies, metal lath, triangle mesh, black and blue annealed steel sheets. Small supplies of lime, cement and wire nails. Especially heavy stocks of lumber, asphalt and road oils; plenty of all other building materials.

Los Angeles—Heavy lumber reserves stored at harbor, 25 mi. from city. All



lumber shipments by water from North; transported by truck to dealers yards. No wood blocks, paving stone or paving blocks used. No market for pine or hemlock.

Denver—Lumber stocks sufficient despite shortage at mills. About 1,000,000 common brick available.

Minneapolis—Face brick two or three weeks behind in deliveries. Cement stocks in good condition with 15,000 to 20,000 bbl. in warehouses. Dealers look for no difficulty in meeting materials demands except from transportation shortage. Lumber stocks unusually large for season; estimated 85,000,000 ft. in Twin City yards.

Detroit—Fair stocks in all sizes of sewer pipe up to 36-in.; small supply of larger pipe. Supply ample for present needs being received from nearby mills. Large orders for late delivery being declined by manufacturers. Ample supply of lime in warehouses and at Michigan and Ohio kilns. Moderate stocks of common brick in local yards. Small quantity of hollow tile at hand; large deliveries take several days. Moderate lumber stocks in dealers yards. Plenty of asphalt and structural steel.

Atlanta—About forty cars each of lime and cement; three to five cars of steel structurals on sidings. Sewer pipe deliveries take from five to seven days; hollow tile, five days. Plenty of brick, asphalt and lumber.

New York—Shortage of building sand during last few weeks. Common brick not coming into market fast enough to supply increasing demand. Builders also experiencing difficulty in obtaining structural steel from mills. Plenty of sewer pipe in warehouses in sizes up to 22-in.; shortage of sizes over 24-in. Sewer pipe is still frequently shipped in gondolas for want of other cars. Mill deliveries of pine lumber take two weeks longer than a month ago.

Philadelphia—Asphalt plentiful; sewer pipe and hollow tile stocks low. Fair supply of lime; no surplus of common brick. Lumber and cement subject to demand in excess of supply.

Railroads Prepare for Record Volume of Traffic

Plans to handle the greatest volume of traffic in the nation's history were decided upon at a meeting of railroad executives held in New York April 10. Since January 1, 1922, according to a report of the Car Service Division of the American Railway Association, railroads have authorized an expenditure of $1,540,000,000 for equipment and trackage; of this sum $440,000,000 was spent in 1922, leaving $1,100,000,000 available for the current year. The report, which was approved at a meeting of the Association of Railway Executives, indicates that car loading records will be broken repeatedly this year. Loadings of more than 1,000,000 cars weekly during thirteen weeks of this year are predicted.

In the formal statement issued after their meeting the railway executives urged that road and building construction be started as early in the season as possible; that cars be loaded to maximum capacity to bring the average up to 30 tons; and that the mileage per car per day be increased to 30 for the entire country. They also impressed on the public the desirability of storing coal during spring and summer and making shipments, where possible, during April, May, June and July to help decrease the usual congestion in September, October and November.

1923 Highway Activity To Exceed Previous Years, Says Roads Bureau

Highway construction will proceed during the coming season on a much more extensive scale than ever before, in the opinion of officials at the Bureau of Public Roads. Not only is the amount of Federal aid money available 30 per cent greater than the amount available last year, but there are large balances from previous years which will be put under contract from this time forward. A portion of that amount will be lost if it is not put under contract before July 1. Since it is improbable that any state will allow any of its Federal aid money to revert to the Treasury, it is expected that an unusual amount of work will be put under contract, particularly in the southern states.

If Florida catches up with the road-building program, it will have to put 900 per cent more road work under contract than was placed under contract last year.

Building Council Bill Passed by Indiana Legislature

The Senate bill designed to create a new state department to be known as the administrative building council of Indiana was passed by the House of Representatives of that state before the adjournment by a vote of 71 to 6. It passed the Senate previously by a vote of 27 to 16. It is expected the bill will be signed by the governor at an early date.

The bill invests the council with power to administer and enforce any and all laws now in force or to be enacted relative to the construction, repair, or maintenance of places of employment and public buildings as shall render the same safe and sanitary; and to ascertain and order such reasonable standards, rules, regulations and specifications of such places as shall be necessary to carry out the purposes of the act. It will give the commission authority over virtually every class of construction in the state except residential construction. It is considered to be the forerunner of a state building commission which will unify the building codes in the various cities and towns.

The chairman of the state industrial board, the secretary of the state board of health and the state fire marshal are to constitute the administrative committee of the council and twelve per-

sons to be named by the governor are to constitute the advisory committee. On the advisory committee the governor must appoint three engineers, three contractors, three architects and three building mechanics from the names submitted, respectively, by the Indiana Engineering Society, Associated Building Contractors of Indiana, Indiana Society of Architects and jointly by the Indiana State Building Trades Council and the Indiana State Council of Carpenters. Members of the commission will receive no pay.

U. S. Steel Raises Wages of Day Labor 11 Per Cent

An 11-per cent increase in the wages of day labor in the plants of its manufacturing subsidiary companies, effective April 16, has been authorized by the United States Steel Corporation. The announcement was made following a special meeting of the finance committee of the corporation held in New York City April 9. It was also recommended to the manufacturing subsidiaries that "other wage rates in the manufacturing plants be equitably adjusted to become effective April 16, 1923."

The increase will effect about 200,000 workers, and will mean an advance to 40c. per hour as against the present rate of 36c. an hour for common labor. The present advance, it is estimated, will increase the company's weekly payroll by about $500,000. The action of the U. S. Steel Corporation, it is predicted, will mean a general upward movement of wages throughout the industry.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of April 5; the next, on May 3.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.44	$4.20	$4.50	+$3.30	$3.45	$3.95	+$3.70	+$4.10	$3.75
Structural rivets, 100 lb.	4.00	4.85	5.25	3.75	4.00	5.15	4.75	4.50	+6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.34	4.10	3.15	+3.22½	3.35	3.97½	3.40	+4.10	+3.50
Steel pipe, black, 2½ to 6 in. lap, discount	51%	52%	45%	59½%	55-5%	38%	38.2@50.2%	45%	32.76
Cast-iron pipe, 6 in. and over, ton	—58.50	55.00	57.00	+57.20	60.50	+67.00	60.00	58.00	+60.00
Concreting Material:									
Cement without bags, bbl	2.70@2.80	+3.25	2.25	2.20	2.39	2.85	2.71	2.90	—2.68
Gravel, ¾ in., cu.yd.	+2.25	+1.90	2.25	2.25	1.75	1.90	2.15	1.25	1.50
Sand, cu.yd.	1.00	1.24	1.87½	2.25	1.00	1.00	1.50	1.25	1.25
Crushed stone, ¾ in., cu.yd.	1.75	2.00	2.50	2.25	2.25	3.50	2.15	3.00	1.90
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	+65.00	+40.00	53.00	—60.00	+45.75	—42.75	39.00	30.00	95.00
Lime, finishing, hydrated, ton	16.80@17.10	23.00	22.50	20.00	25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	3.00@3.25	—1.40	2.50	1.50	1.25	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	23.50	13.00	11.60	11.00	17@19	12.00	15.00	13.00	16.50
Hollow building tile, 4x12x12, per block	Not used	+.0893	.115	....	.0836	.065	....	.11	.115
Hollow partition tile 4x12x12, per block	.1314	+.0893	.115	.0674	....	.065	.108	.11	....
Linseed oil, raw, 5 bbl. lots, gal.	+1.13	+1.25	+1.32	+1.25	+1.29	+1.39	+1.34	.86	—1.16
Common Labor:									
Common labor, union, hour	+.45@.70	.35	.30@.50	.....	.....	.50@.55	.56¼	....	.....
Common labor, non-union, hour	+.45@.70	.30	.30@.50	.72½	.35@.50	.35@.50	.50	.30@.70	.25

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Cement and concrete laborers' rate, 81¼c.; pick and shovel men, 60c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in iron bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine casing. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 98.06). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $32.76; 6-in., $108.

Changes Since Last Week

Owing to congestion in steel bar mills due to volume of new business, prices are somewhat higher this week at $2.50@$2.80 per 100 lb., Pittsburgh, on specified deliveries, against $2.50@$2.75, one week ago. Many producers are turning down new orders. Structural shapes quoted at $2.45@$2.70, f.o.b. mill; leading interests unable to handle new tonnages. Plates firm at $2.50@$2.75 on new business for prompt delivery. Railroad car material in heavy demand at plate mills. Steel shapes advanced 10c. per 100 lb. in Chicago, San Francisco and Seattle warehouses; bars, 10c. in Seattle, 12½c. in Chicago and 25c. per 100 lb. in Montreal, during last two weeks.

Wages of steel mill laborers will be increased 11 per cent, effective April 16, involving at least 200,000 men. The rate for this grade of labor was $2 per 10-hr. day in 1915, which was in turn advanced to $5.06 in 1920, dropping to $3 in 1921 and later increased to $3.60 in 1922. The latest advance brings the schedule to $4 per day, or 100 per cent above the 1915 rate.

Cast-iron pipe advanced $2 in Denver and $4 in Chicago; New York, however, reports decline of $3.50 per ton. Yellow pine timbers up $2 in New York and Atlanta; down 50c. per M ft. b.m. in Chicago. Douglas fir rose $1 in Minneapolis; but it declined somewhat in Denver.

Linseed oil rising steadily due to seed shortage. Advances reported as follows: San Francisco, 19c.; Dallas, 16c.; Denver, 14c.; Chicago, 10c.; Atlanta, 8c; Minneapolis, 7c. and New York 5c. per gal.

Gravel, ¾-in., advanced 25c. in New York and 15c. per cu. yd. in Atlanta, during last two weeks. Sand prices firm but unchanged in New York following recent period of adverse weather conditions and sustained demand.